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P83-10047

STS-6
Sixth Space Shuttle Mission

First Flight Of The Challenger

Press Kit

April 1983

56

RELEASE NO: 83-36 April 1983

CONTACTS

Jim Kukowski
Headquarters, Washington, D.C.
(Phone: 202/755-3090)

Dick Young
Kennedy Space Center, Fla.
(Phone: 305/867-2468)

Terry White
Johnson Space Center, Houston, Texas
(Phone: 713/483-5111)

John Taylor
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/453-0031)

Ralph B. Jackson
Dryden Flight Research Facility, Edwards, Calif.
(Phone: 805/453-8381)

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IN MEMORIAM

JIM MALONEY

1923 - 1982

Houston Post

That empty chair at the STS-6 preflight briefings would have been filled by Jim Maloney, Houston Post space reporter, had he not died Dec. 5 of complications from a fall on Thanksgiving Day.

Jim covered manned spaceflight as well as unmanned planetary expeditions for 20 years, beginning when the Manned Spacecraft Center migrated from Langley to Houston. He had a knack for translating "Space-Speak" into English understandable to Joe Sixpak. His style was low-key until he set off in dogged pursuit of a straight answer from a waffling briefer or interviewee.

Space correspondents and NASA PIOs alike shall miss his ruddy Irish face, with eyes peering over narrow reading glasses, with his eyebrows often near liftoff in quiet awe of the events he covered. St. Peter likely will forgive Jim's forgetting his media badge.

(Contributions to a scholarship fund benefiting space science students at Rice University and the University of Houston may be made in Jim Maloney's name in care of: Astronaut Office, Code CB, NASA Johnson Space Center, Houston, TX 77058)

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NASA News

National Aeronautics and
Space Administration

Washington, D C 20546
AC 202 755-8370

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For Release.

IMMEDIATE

RELEASE NO: 83-36

CHALLENGER FIRST FLIGHT TO DEPLOY TDRS-A AND FEATURE EVA

A large telecommunications satellite will be the first major payload for the newest Space Shuttle orbiter, Challenger. The winged vehicle will carry the Tracking and Data Relay Satellite, TDRS-A, into low earth orbit for deployment and eventual insertion into geosynchronous orbit. In addition, an EVA (extra-vehicular activity) will be conducted by two mission specialists.

Launch from the Kennedy Space Center, Fla., is scheduled for April 4. A four-man crew will be aboard the Challenger on its maiden flight. Launch time will be 1:30 p.m EST. The mission is designed to last 5 days, 19 minutes, with landing scheduled for approximately 1:49 p.m. EST at Edwards Air Force Base, Calif.

The mission will be commanded by Paul J. Weitz (pronounced WHITES), a veteran of the Skylab 2 mission conducted in 1973. The STS-6 pilot is Karol J. Bobko. Mission Specialists for the flight are Dr. Story Musgrave and Donald H. Peterson.

March 18, 1983

An Air Force developed inertial upper stage (IUS) will be used to boost the 2,268-kilogram (5,000-pound) special purpose communications satellite to an altitude of 35,888 kilometers (22,300 statute miles) above the equator. TDRS-A (TDRS-1 in orbit) is the first of three similar satellites to be deployed and to be used for Space Shuttle and other NASA space communications requirements.

A 3-1/2 hour extravehicular activity will be conducted on flight day four by mission specialists Musgrave and Peterson. The space walk will be similar in many respects to the one that was cancelled during STS-5 last November when equipment failures in both astronaut space suits forced mission officials to scrub the walk in the orbiter Columbia's payload bay.

The four-man crew will conduct several on-orbit experiments designed to increase present knowledge of "zero g" materials processing and understand better the nature of electrical storms.

Three small self-contained payloads, "Getaway Specials," will also be flown aboard Challenger.

Landing will be at Edwards Air Force Base on Runway 22-04 at the Mojave Desert facility. The lakebed surface is not acceptable for landing.

Challenger is the second of four operational orbiters to be built. Unlike Columbia, Challenger has no ejection seats. All four crewmen will be seated on the flight deck during launch and landing.

There has been an overall weight reduction in the orbiter of about 1,128 kg (2,488 lb.).

Orbiter improvements include a heads-up display landing system. Important landing information will be viewed by the commander and pilot on a special see-through glass in front of the cockpit windows.

Several changes have been made to the Challenger's thermal protection system (TPS). More than 600 thermal tiles have been replaced by a blanket-like thermal material. All 30,000 tiles have been specially treated (densified) to improve their durability.

The first lighweight external tank (ET) will fly on STS-6. The tank is approximately 4,536 kg (10,000 lb.) lighter than the standard tank previously used. Lighter weight solid rocket booster motor casings will be used for the first time. Each booster is 1,814 kg (4,000 lb.) lighter, thereby increasing payload weight capacity by 408 kg (900 lb.).

In addition to the weight savings in the orbiter, external tank and solid rocket boosters, the Space Shuttle main engines will perform at 104 percent of rated-power-level as against 100 percent for the main engines aboard Columbia.

Challenger will not carry a development flight instrumentation (DFI) package in the payload bay, but will carry a much smaller instrumentation package to collect flight data.

TDRS-A, owned and operated for NASA by Space Communications Co. (SPACECOM), is the first of three identical Tracking and Data Relay Satellites planned for the TDRS system. The system will be equipped to support a variety of user spacecraft simultaneously.

The Space Tracking and Data network is presently able to provide communications support for only about 15 percent of each Space Shuttle orbital period. When fully established, the TDRSS network will provide a relay capability for almost the entire orbital period of a low earth orbit spacecraft. The primary TDRSS ground station is at White Sands, N.M.

TDRS-A measures more than 17.4 meters (57 feet) across when the solar panels are fully extended. Two single access antennas each measure 4.9 m (16 ft.) in diameter and when deployed in space measure more than 12.9 m (42 ft.) from tip to tip.

The inertial upper stage (mated to the TDRS-A) will be deployed from the Challenger's payload bay 10 hours after launch. There are two additional opportunities for deployment at 11 hours, 30 minutes and 13 hours into the flight, if needed.

The STS-6 crew will position the IUS/TDRS-A to its 59 degree deployment angle in the bay. Deployment occurs when explosive bolts are fired that release an ejection spring that pushes the payload away from the Challenger.

Musgrave and Peterson will conduct their extravehicular activity on the fourth day of the STS-6 mission. The two mission specialists will move throughout the payload bay of the Challenger testing a variety of support systems and equipment designed to aid future EVAs.

NASA scientists will conduct electrophoretic separation processes and further investigate the effects of gravity on continuous flow electrophoresis. The Continuous Flow Electrophoresis System (CFES), developed by McDonnell Douglas Astronautics Co., St. Louis, and operated with NASA as a joint endeavor, also flew on STS-4.

The Monodisperse Latex Reactor is going into space for the third time aboard the Shuttle. The materials processing device will attempt to produce, in quantity, very tiny, identical latex beads (10 micron diameter range).

The Nighttime/Daytime Optical Survey of Lightning (NOSL) experiment will record lightning activities with motion pictures and photo cell readings. The survey will be conducted by crew members as the Challenger orbits above and near storm centers on earth.

An artifical snow experiment, sponsored by a Tokyo newspaper; a seed germination experiment owned by a South Carolina seed firm; and a multiple disciplinary experiment built by U.S. Air Force Academy students will make up the "Getaway Special" payload complement.

The snowflake experiment, proposed by two Japanese high school students, will attempt to produce artifical snow in zero gravity and videotape the results with onboard television cameras.

The George Park Seed Co., of Greenwood, S. C., will send 11.3 kg (25 lb.) of fruit and vegetable seeds into orbit inside the small self contained payload canister to determine how seeds must be packaged to withstand space flight.

Six different experiments are contained in the U.S. Air Force Academy canister. Developed in an engineering design course at the academy over the past five years, the projects range from metal purification and electroplating to effects of weightlessness and space radiation on micro-organism development.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

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STS-6 PRESS BRIEFING SCHEDULE

T-2 DAYS

EST	CST	PST	BRIEFING	ORIGIN
9:00 a.m.	8:00 a.m.	6:00 a.m.	Mission Countdown Status	KSC
9:30 a.m.	8:30 a.m.	6:30 a.m.	Crew Activity/Timeline and EVA	KSC
10:30 a.m.	9:30 a.m.	7:30 a.m.	STS Improvements TDRSS IUS	KSC
1:30 p.m.	12:30 p.m.	10:30 a.m.	Experiments: CFES MLR NOSL	KSC
2:30 p.m.	1:30 p.m.	11:30 a.m.	GAS Program: Park Seed Co. Asahi Shimbun Air Force Academy	KSC
T-1				
9:00 a.m.	8:00 a.m.	6:00 a.m.	Mission Countdown Status	KSC
10:30 a.m.	9:30 a.m.	7:30 a.m.	Prelaunch Press Briefing	KSC
T-DAY				
10:30 a.m.	9:30 a.m.	7:30 a.m.	Post Launch Briefing	KSC only
Launch through EOM			See change of shift briefing schedule	JSC
T+5				
3:00 p.m.	2:00 p.m.	12:00 p.m.	Post Landing Press Conference	DFRF
T+6				
2:00 p.m.	1:00 p.m.	11:00 a.m.	Orbiter Status Briefing	DFRF

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TV SCHEDULE

The schedule for television transmissions from Challenger and for the change of shift briefings from the Johnson Space Center will be available during the mission at the KSC, MSFC, JSC, DFRF, GSFC and NASA Headquarters news centers. The television schedule will be updated on a daily basis to reflect any changes dictated by mission operations.

SUMMARY TIMELINE

A revised Summary timeline for the STS-6 mission was not available for inclusion in the press kit when the document went to press. Flight plan and timelines will be available at KSC, MSFC, JSC, DFRF, GSFC and NASA Headquarters news centers shortly before the mission.

LAUNCH PREPARATIONS, COUNTDOWN AND LIFTOFF

The Shuttle Orbiter Challenger arrived at Kennedy Space Center from California atop the 747 Shuttle Carrier Aircraft on July 5, 1982. Pre-flight checkout was performed in Bay 2 of the Orbiter Processing Facility, a sophisticated structure analogous to an aircraft hangar.

Assembly of the STS-6 vehicle began Oct. 1 with build-up of the twin solid rocket boosters on the deck of Mobile Launcher Platform-2. Previous Shuttle vehicles were launched from MLP-1. Stacking of the twin booster rockets was completed Oct. 14 and the external tank was mated with the boosters on Oct. 21.

Major work completed in the OPF included a Dynamic Stability Test, and the installation of the three Space Shuttle Main Engines and two Orbital Maneuvering System pods on the Challenger.

An Orbiter Integrated Test was successfully conducted Nov. 5-7 to verify compatibility of various orbiter subsystems.

Challenger was moved to the Vehicle Assembly Building on Nov. 23 and attached to its external tank and booster rockets. A partial Shuttle Interface Test was conducted from Nov. 27-29 to verify the mechanical, fluid and electrical connections between the orbiter and its other elements. The test was completed at the launch site.

The Space Shuttle was moved to Pad A of Complex 39 on Nov. 30 to undergo final checkout and propellant servicing for launch.

Preflight servicing of Challenger with hypergolic propellants was conducted from Dec. 8-11, followed by the start of preparations for the first 20-second static test firing of Challenger's three main engines.

The Flight Readiness Firing, designed to verify the integrity of the orbiter Challenger and its new, more powerful main engines, was conducted on Dec. 18. The firing also served as a means to test the outer insulation of the new lightweight external tank and provided the opportunity to run Challenger's three auxiliary power units to certify the units for flight.

During the 20-second test firing, engineers detected a level of gaseous hydrogen in the orbiter aft engine compartment in excess of normal operating limits. Extensive post-FRF inspections of the Shuttle main engines to pinpoint the source of the hydrogen began immediately. At the same time, preparations for Challenger's maiden launch continued.

The KSC launch team performed a mock launch and reentry test on Dec. 23 and began preparing the the STS-6 payload delivery to the launch pad.

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The Tracking and Data Relay Satellite with its Inertial Upper Stage was moved to Pad 39-A and installed in the Payload Changeout Room on Dec. 27. Functional checks were performed on the upper stage and sophisticated communications satellite and preparations were made to service the TDRS' attitude control system with hydrazine fuel.

The Terminal Countdown Demonstration Test with the STS-6 flight crew was conducted on Jan. 11 as a final demonstration of vehicle, flight software and flight crew readiness for launch.

Meanwhile, engineers were unable to locate the source of the hydrogen and NASA officials made the decision on Jan. 7 to perform a second Flight Readiness Firing. Instrumentation was added inside and outside the orbiter's aft compartment to determine if the hydrogen was coming from an internal or external source; and determine as closely as possible the location of the leakage if it was internal to the orbiter's aft engine compartment. The payload was removed from the Payload Changeout Room on Jan. 15 and taken back to the Vertical Processing Facility where it remained until the second firing was completed.

The second Flight Readiness Firing was conducted on Jan. 25. High levels of hydrogen gas were again detected in the aft compartment repeating the problem experienced during the first engine test firing. Test data revealed the hydrogen source to be inside the aft compartment.

After days of painstaking analysis, a 3/4-inch crack was found in Space Shuttle Main Engine No. 1's main combustion chamber coolant outlet manifold. Special tests were performed to verify the crack could account for the quantity of hydrogen that was detected in the aft compartment. Extensive checks were also conducted of the No. 2 and No. 3 engines.

Discovery of the hydrogen source and subsequent analysis confirmed that a third Flight Readiness Firing would not be necessary prior to the STS-6 launch, thus clearing the way to return the STS-6 payload to the launch pad.

The TDRS satellite with its Inertial Upper Stage was again delivered to the pad on Feb. 4 and installed in the Payload Changeout Room the following day.

On Feb. 28 strong winds whipped across the Cape Canaveral area breaching the seal between the Rotating Service Structure's Payload Changeout Room and the Challenger. As a result of the winds a fine layer of particulate matter was deposited on the TDRS. After a thorough investigation into the contamination, an inspection and cleaning program was instituted by Goddard Space Flight Center and the TDRSS contractors. Cleaning of the satellite began on March 14 and was completed March 17. The spacecraft was returned to the Challenger cargo bay on March 19.

Engine No. 1 (2011) was removed on Feb. 4. Its replacement, Engine No. 2016, arrived from NASA's National Space Technology Laboratories in Bay St. Louis, Miss., that same day and was delivered to the Vehicle Assembly Building for its receiving inspection. While in the VAB, Engine 2011's low pressure oxidizer turbo pump was removed and installed on engine 2016.

Leak checks performed on the engine revealed a leak in an inlet line to the liquid oxygen heat exchanger used to covert liquid oxygen into gasous oxygen which is then routed back through the MPS for external tank pressurization. NASA officials decided to replace Engine 2016 with another Space Shuttle Main Engine -- No. 2017. The new engine completed certification firings at the National Space Technology Laboratories on Feb. 15 and was readied for delivery to Kennedy.

In parallel with the engine work, payload activities continued at the launch site. Functional checks with the upper stage and the spacecraft were repeated and TDRS' attitude control system was serviced prior to the payload's Feb. 22 installation in the cargo bay.

Electrical tests to verify orbiter-to-payload interfaces were conducted Feb. 24-25, completing checkout of the STS-6 payload.

On Feb. 26, while conducting pre-flight leak checks of the Shuttle's remaining engines, a leak was discovered coming from the No. 2 (2015) engine. Further analysis located the source of the leak to be a hairline crack in a 1/2-inch fuel line leading into the injector's augmented spark igniter chamber. The No. 3 (2012) engine was boroscoped revealing a crack in the same location.

The failure was at a location in the line where a metal sleeve was brazed to the line. The sleeve acted as a shock absorber to prevent chaffing of the line at the point where it passed through a cover over the injector.

The line was in a location that prevented an in-place repair, thus requiring both engines to be removed. Engine 2015 was removed Feb. 28 and Engine 2012 was removed March 1. Both engines were taken to the Vehicle Assembly Building where the engines were repaired.

The repair consisted of cutting out a 10-inch section of the line containing the sleeve area, and replacing it with an identical section of tubing, but without the sleeve.

Engine 2017 arrived from Mississippi on March 3 and was taken to the Vehicle Assembly Building. An identical modification was made on that engine, although analysis did not show a crack in the fuel line.

Engine No. 2 (2015) was the first to be repaired. It was returned to the pad on March 8. Engine No. 3 (2012) was installed on March 10. Engine No. 1 (2017) was delivered to the pad on March 11. Verification checks of Challenger's main engines for flight resumed on March 14.

The removal, cleanup, reinstallation and pre-flight checkout of the TDRS-A and IUS was accomplished in parallel with engine reverification activities and countdown preparations.

Pre-countdown activities, which includes final ordnance operations, checks of the Shuttle Range Safety System and pressurization of Orbital Maneuvering System propellant tanks to regulator lockup, were scheduled to begin March 28. Actual pick up of the 111-hour long Shuttle Launch Countdown was set for March 31.

STS-6 will be launched from Firing Room 1 of the Launch Control Center by a government/industry team.

MAJOR COUNTDOWN MILESTONES

Count Time	**Event**
T-93 hours	Call to stations
T-82 hours	Pressurize maneuvering and reaction control system propellant tanks.
T-40 hours	Load cryogenics into orbiter fuel cell supply tanks and pressurize.
T-34 hours	Six hour built-in-hold.
T-27 hours	Start external tank loading preparations.
T-19 hours	Perform interface check with Mission Control.
T-11 hours	10 hour 40 minute built-in-hold.
T-11 hours (counting)	Retract Rotating Service Structure.
T-7 hours	Activate fuel cells and begin load sharing
T-6 hours	Start cyrogenic propellant chilldown and load.
T-3 hours	1 hour built in hold. Cryogenic load complete.
T-3 hours (holding)	Wake flight crew (Launch -4 hours, 10 minutes).
T-2 hours, 50 minutes	Suit flight crew (Launch -3 hours, 10 minutes).
T-2 hours, 30 minutes	Crew departs for pad (Launch -2 hours, 50 minutes).
T-1 hour, 55 minutes	Start crew entry (Launch -2 hours, 15 minutes).
T-61 minutes	Inertial Measurement Unit begins preflight alignment.
T-20 minutes	10 minute built-in-hold
T-20 (counting)	Configure orbiter computers for launch.

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T-9 minutes	10 minute built-in-hold. Status check and Launch Director "go."
T-9 minutes (counting)	Start ground launch sequencer.
T-7 minutes	Retract orbiter access arm.
T-5 minutes	Start Auxiliary Power Units. Arm range safety, SRB ignition systems.
T-3 minutes, 30 seconds	Orbiter goes on internal power.
T-2 minutes, 55 seconds	Pressurize liquid oxygen tank and retract gaseous oxygen vent hood.
T-1 minute, 57 seconds	Pressurize liquid hydrogen tank.
T-31 seconds	Go from ground computers for Orbiter computers to start launch sequence.
T-28 seconds	Start SRB hydraulic units.
T-6.8 seconds	Go for main engine start.
T-3 seconds	Main engines at 90 percent thrust.
T-0	Solid rocket booster ignition, holddown post release and liftoff.
T+7 seconds	Tower clear, control switches to Mission Control.

LAUNCH WINDOW

STS-6 will be launched from Complex 39's Pad A at Kennedy Space Center. The launch window in April extends from 1:30 p.m. EST, to about 1:50 p.m. EST. The window's brevity is driven by sunset at Dakar, Senegal, for a trans-Atlantic abort.

The window assumes a nominal landing at Edwards Air Force Base, Calif.

STS-6 will be launched into a 298-km (185-mi.) circular orbit with an inclination to the equator of 28.5 degrees.

FLIGHT OBJECTIVES

Challenger's primary cargo for STS-6 is the first of two Tracking and Data Relay Satellites which, by STS-9 in September 1983, will provide continuous voice and data from Shuttle orbiters except for one narrow patch of "loss of signal" over Asia. The TDRS spacecraft are propelled to their geosynchronous parking orbits by inertial upper stage solid-rocket two-stage boosters after deployment from Challenger's payload bay.

Mission specialists Don Peterson and Dr. Story Musgrave will don extravehicular mobility units (EMU) on the fourth day of the flight to check out the new-generation Shuttle spacesuits and to gain experience in simulated spacewalk tasks in the payload bay. A similar spacewalk was dropped from STS-5 when the suit pressure regulators and a fan malfunctioned.

STS-6 experiments include a reflight of the Continuous Flow Electrophoresis System (CFES), flown earlier on STS-4. The system is in a module attached to the left middeck wall where food galleys later will be fitted in orbiters.

Other STS-6 experiments are the Monodisperse Latex Reactor (MLR) and Nighttime/Daytime Optical Survey of Lightning (NOSL). Three getaway specials (GAS) canisters in the payload bay contain experiments flown by the U.S. Air Force Academy, Park Seed Co., and Asahi Shimbun of Japan.

In addition to payloads and experiments, two life sciences detailed test objectives are listed for STS-6: Validation of Predictive Test and Countermeasures for Space Motion Sickness, and Cardiovascular Deconditioning Countermeasures.

CHALLENGER: THE NEW ORBITER

Each new spacecraft to come off the assembly bays in the orbiter manufacturing facility at Palmdale carries improvements in structure, materials and equipment that are not apparent to the observer.

Challenger weighs 1,128 kg (2,486 lb.) less than Columbia as a result of weight-saving structural changes that include use of lightweight honeycomb for such things as landing gear doors and vertical tail tip and leading edge.

Much of the secondary support structure in the aft fuselage around the main engine thrust frames has been eliminated or combined with the primary structure. The main engine heatshields are lighter, and in the mid-fuselage the titanium cryogenic tank supports have been replaced with tubing made of boron-aluminum. Flexible reusable surface insulation blankets have replaced glass tiles over the two orbital maneuvering system pods.

Thermal protection system silica glass tiles over the rest of Challenger's skin have been densified for improved bonding, based on the lesson learned from Columbia's early tile problems.

In the crew cabin, ejection seats and their heavy rails are absent from Challenger, replaced by operational crew seats. Challenger also has heads-up displays for the commander and pilot which project apparent images of runway, velocity and flare graphics onto a clear screen between the pilots and the front windows. Other flight deck controls and displays are the operational flight type. Emergency crew egress on the ground after landing is through the ejectable left overhead window.

CONFIGURATION

Outwardly, Challenger may not look greatly different from her sister orbiter Columbia, but weight-saving design changes have trimmed Challenger by 1,128 kg (2,486 lb.). Challenger weighs 67,876 kg (149,642 lb.) "dry" while Columbia weighs 69,004 kg (152,128 lb.).

Loaded with crew, cargo, consumables and experiments, Challenger will weigh 117,267 kg (258,529 lb.) at launch. Heaviest cargo to date, TDRS-A and its cradle weigh 19,550 kg (43,100 lb.) (TDRS-A 2,268 kg (5,000 lb.); IUS 14,746 kg (32,509 lb.); cradle 2,536 kg (5,592 lb.). The Mini-Modular Auxiliary Data System (Mini-MADS), replacing the 4,476 kg (9,868 lb.) Developmental Flight Instrumentation (DFI) flown on earlier flights, weighs 298 kg (656 lb.). Three GAS canisters weighing 552 kg (1,270 lb.) and various payload attachment hardware bring the total weight in the payload bay to 21,144 kg (46,615 lb.).

The STS-6 vehicle, with lightweight external tank and solid rocket booster casings, will weigh 2,036,856 kg (4,490,498 lb.) at SRB ignition just 880 kg (1,939 lb.) more than the STS-5 vehicle at launch.

UPRATED ENGINES

The Challenger engines, numbers 2012, 2015 and 2017, will deliver 104 percent of rated thrust, a higher thrust level than the engines on Columbia, which were operated at 100 percent. For each percent increase of thrust over 100 percent, the Shuttle gains 454 kg (1,000 lb.) of payload carrying capability.

This higher thrust level was accomplished by incorporating redesigned engine parts into the original engine design. The changes were necessary because of higher temperatures, pressures and pump speeds that the new engines will encounter at the higher thrust level. All the changes were proved out in a very intense engine testing program, which included more than 45,000 seconds of engine firings.

Significant engine changes include: use of higher strength liquid oxygen posts in the main injector due to higher temperatures and pressures; use of a modified fuel preburner because of previous erosion of turbine blades and thermal shield nut erosion; and using thicker tubes and redesigning coolant supply lines in the nozzle to accommodate high loads at ignition.

The test program and manufacture of the main engines is carried out by the Rocketdyne Division of Rockwell International under the direction of the NASA Marshall Space Flight Center, Huntsville, Ala.

LIGHTER WEIGHT BOOSTERS

A new, lighter-weight motor case has been developed for the Space Shuttle's solid rocket boosters which will increase the Shuttle's weight carrying capability by about 363 kg (800 lb.). Weights may vary slightly for each mission.

Each booster's motor case used on STS-6 and future flights will weigh about 44,452 kg (98,000 lb.) which is approximately 1,814 kg (4,000 lb.) less than those flown on previous Shuttle flights. The weight reduction was achieved by reducing the thickness of the casings' steel skin about two-hundredths to four-hundredths of an inch. Areas of the cases affected by the reduction are the cylindrical, attach and stiffener segments.

The thinner casings of the motors will not affect their reusability. Also, the lighter case segments will be interchangable with the heavier cases flown on previous Shuttle flights.

The motor cases for the boosters are manufactured by the Rohr Corp. for the motor prime contractor, the Wasatch Div. of Morton Thiokol Corp., Brigham City, Utah, under the direction of Marshall Space Flight Center.

LIGHTWEIGHT TANK

Beginning with the external tank built for use on STS-6, all future tanks will be more than 4,536 kg (10,000 lb.) lighter than the tank which flew on the Space Shuttle's maiden flight in April 1981. Although, the weight of each future tank may vary slightly, each will weigh about 30,390 kg (67,000 lb.).

The advantage of using a lighter weight tank is that for each pound of weight reduced from the tank, the Shuttle gains almost an extra pound of cargo carrying capability.

The weight reduction was accomplished by eliminating portions of stringers (structural stiffeners running the length of the hydrogen tank), using fewer stiffener rings and by modifying major frames in the hydrogen tank.

Also, significant portions of the tank are milled differently to reduce thickness, and the weight of the tank's aft solid rocket booster attachments was reduced by using a stronger, yet lighter and less expensive titanium alloy.

Several hundred pounds were eliminated earlier by deleting an antigeyser line. The STS-5 tank was the first flown with this modification.

Development is continuing to further reduce the weight of future tanks.

The external tank is actually made up of two tanks and a collar-like intertank which connects the two. The two individual tanks carry the liquid hydrogen and liquid oxygen for the Space Shuttle's three main engines. Total length and diameter of the tank remains unchanged due to the weight reduction.

The final 34,927 kg (77,000 lb.) tank, which was manufactured earlier than the lighter-weight tank used for STS-6, will be flown on STS-7.

The tanks are manufactured by the Michoud Division of Martin Marietta Aerospace, near New Orleans, under the direction of Marshall Space Flight Center.

STS-6 EXTERNAL TANK WEIGHT REDUCTION SUMMARY

Intertank	635 kg	(1,400 lb.)
Liquid Hydrogen Tank	1,500 kg	(3,300 lb.)
Thermal Protection System	600 kg	(1,326 lb.)
Propulsion System (includes lines and valves connecting the tank and orbiter)	150 kg	330 lb.)
Instrumentation	907 kg	(2,000 lb.)
All Other (includes attach points, electrical systems, range safety, etc.)	907 kg	(2,000 lb.)
Total Weight Reduction		10,356 lb.

WHAT IF THINGS GO WRONG

Shuttle launch abort philosphy aims toward safe and intact recovery of the flight crew, the orbiter and the payloads.

In descending order of desirability, abort modes are as follows:

* **Abort-to-orbit (ATO)** - partial loss of main engine thrust late enough to permit reaching a minimal 194-km (105-nm) orbit with orbital maneuvering system engines.

* **Abort-once-around (AOA)** - earlier main engine shutdown, but near enough orbital speed to allow one orbit around to Northrup Strip (Space Harbor) at White Sands Missile Range, N.M.

* **Trans-Atlantic abort landing (TAL)** - loss of two main engines midway through powered flight, forcing a landing at Dakar, Senegal International Airport.

* **Return to Launch Site (RTLS)** - early shutdown of one or more engines and without enough energy to make Dakar; pitch-around and thrust back toward Kennedy Space Center until within gliding distance of Shuttle runway.

STS-6 contingency landing sites are Kennedy; Edwards Air Force Base, Calif.; White Sands Missile Range, N.M.; Hickam Air Force Base/Honolulu International, Hawaii; Kadena Air Force Base, Okinawa; and Rota Naval Air Station, Spain.

LANDING AND POSTLANDING OPERATIONS

The Kennedy Space Center is responsible for ground operations of the orbiter vehicle once it has rolled to a stop on the runway at Edwards, including preparations for returning the vehicle to Kennedy Space Center to be readied for its next mission.

After Challenger has rolled to a stop, the flight crew will begin safing vehicle systems. At the same time, the recovery convoy will be making its way toward the vehicle.

Specially-garbed technicians will first determine that residual hazardous vapors are below significant levels in order for other safing operations to proceed. A mobile wind machine is positioned near the vehicle to disperse highly concentrated levels of explosive vapors.

Once the initial safety assessment is made, access vehicles will be positioned at the rear of the orbiter so that lines from ground purge and cooling vehicles can be connected to the T-0 umbilical panels on the aft end of the orbiter.

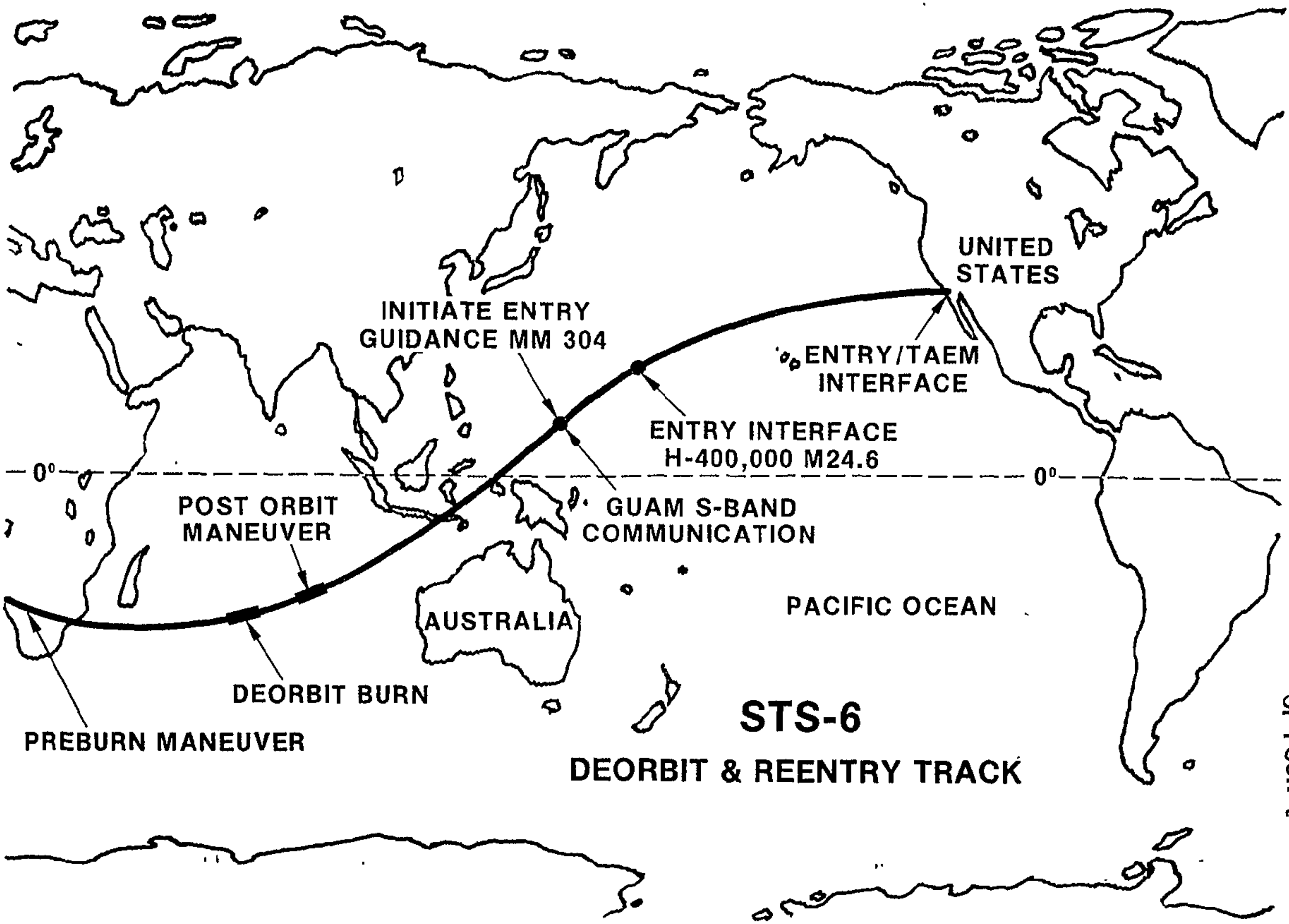
Freon line connections will be completed and coolant will begin circulating through the umbilicals to aid in heat rejection and protect the orbiter's electronic equipment. Other lines will provide cool, humidified air through the umbilicals to the orbiter's payload bay and other cavities to remove any residual explosive or toxic fumes and provide a safe, clean environment inside the Challenger.

The mobile white room will be moved in place around the crew access hatch once it is verified there are no concentrations of toxic gases around the forward part of the vehicle. The hatch will be opened and the flight crew will leave the orbiter. Other astronauts will replace the flight crew and complete safing of the vehicle.

A tow tractor will be connected to Challenger and the vehicle will be pulled off the runway at Edwards and positioned inside the Mate/Demate Device at the nearby Dryden Flight Research Facility.

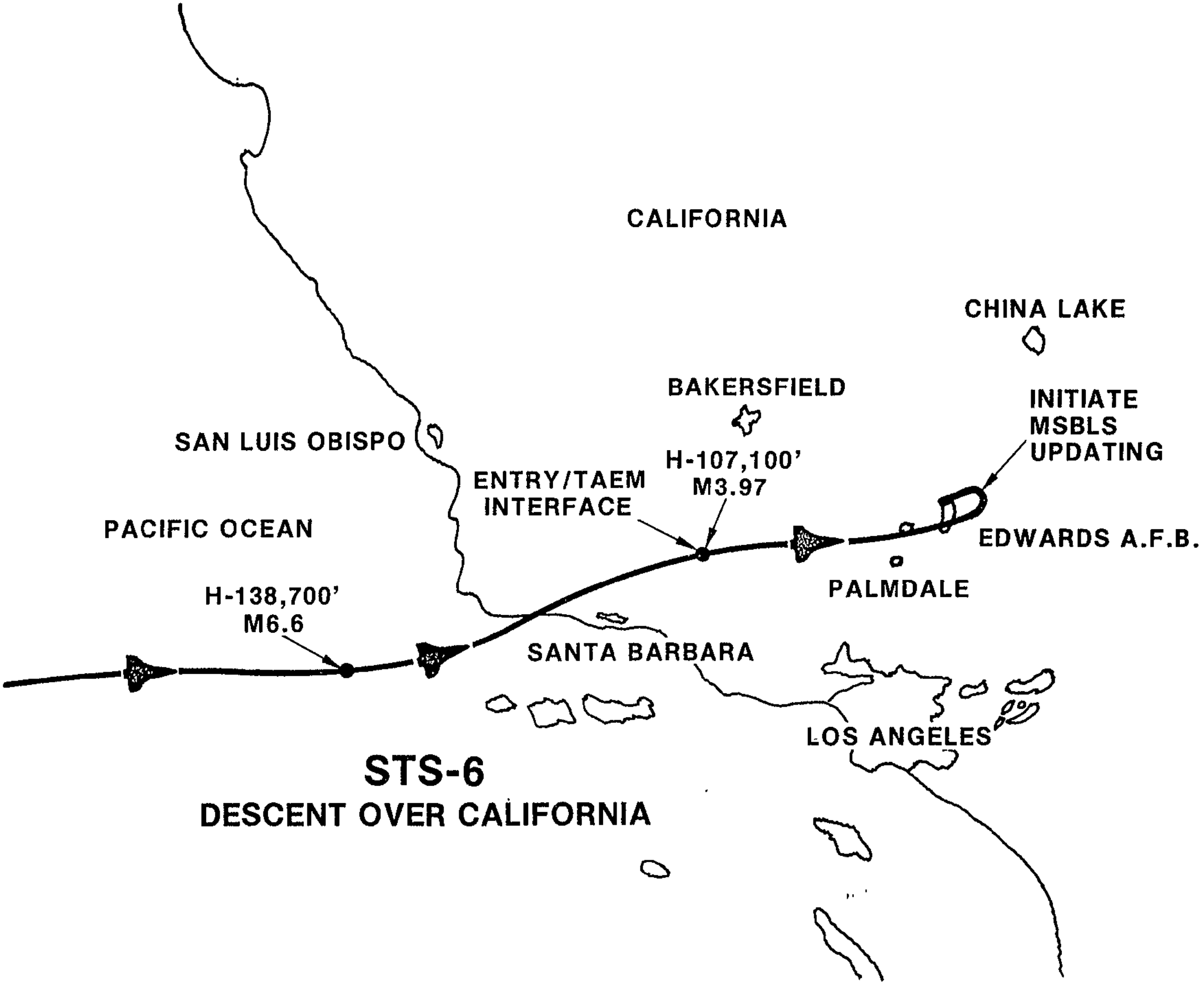
At the Mate/Demate Device, Challenger's fuel cell storage tanks will be drained and unused pyrotechnic devices will be disconnected. Plugs will be installed in engine nozzles and vent ports and the aerodynamic tail cone will be installed over the three main engines. The orbiter will then be bolted on top of the 747 Shuttle carrier aircraft.

The 747 is scheduled to leave California on its one-day ferry flight to Kennedy six days after landing. There will be a stop to refuel the 747 and to change flight crews. Weather permitting, the ferry flight may continue on the same day.



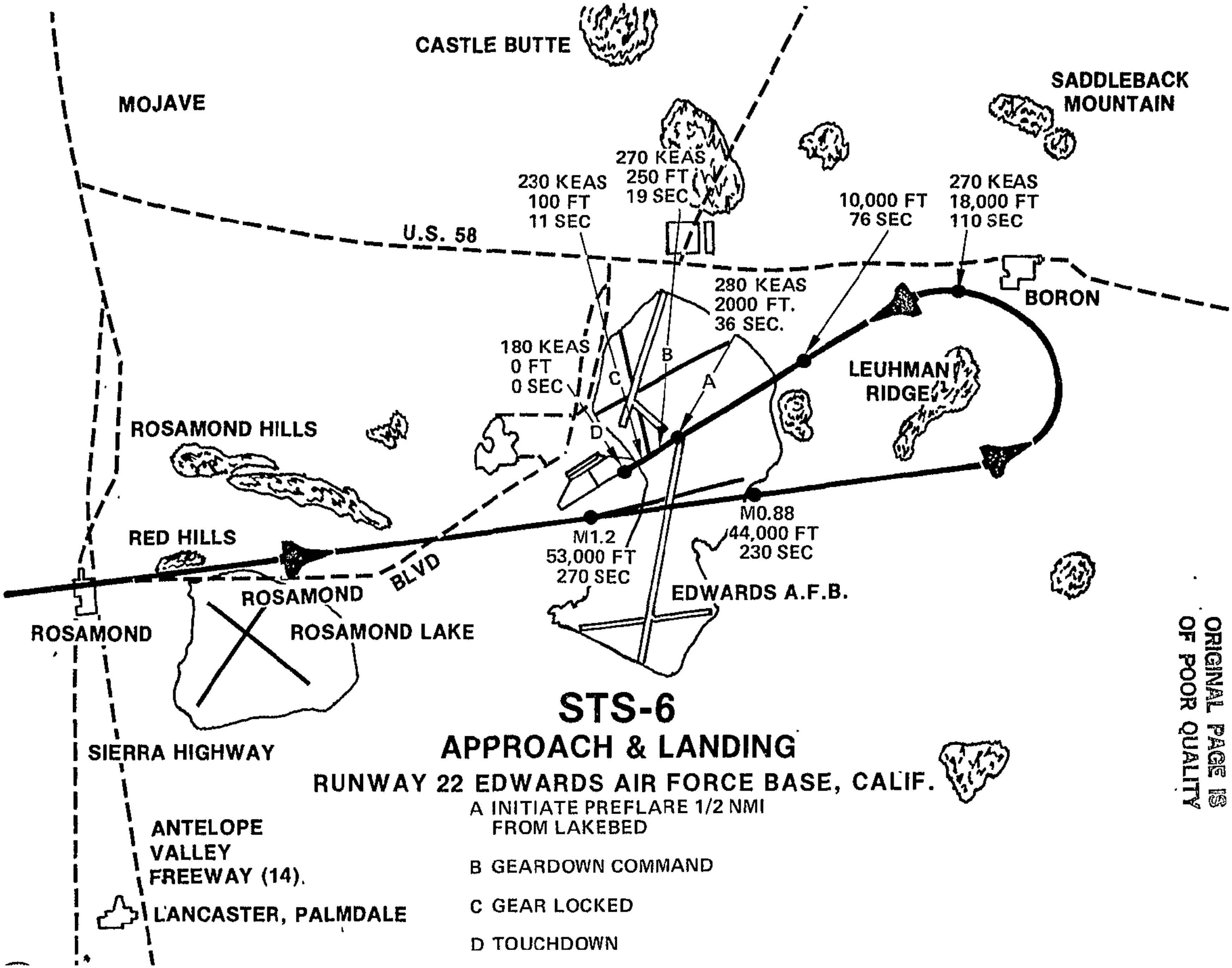
STS-6

DEORBIT & REENTRY TRACK



STS-6

DESCENT OVER CALIFORNIA



STS-6
APPROACH & LANDING
RUNWAY 22 EDWARDS AIR FORCE BASE, CALIF.

A INITIATE PREFLARE 1/2 NMI FROM LAKEBED

B GEARDOWN COMMAND

C GEAR LOCKED

D TOUCHDOWN

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TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS)

TDRS-A is the first of three identical spacecraft which are planned for the TDRS system. The TDRS system was developed following studies in the early 1970s which showed that a system of telecommunication satellites operated from a single ground station could better support the Space Shuttle and planned scientific and application mission requirements and, at the same time also halt the spiralling cost escalation of upgrading and operating a worldwide tracking and communications network of ground stations.

In addition to the Space Shuttle, the TDRSS will be equipped to support up to 26 user satellites simultaneously and will provide two basic types of service: a multiple access service which can relay data from as many as 20 low data rate user satellites simultaneously, and a single access service which will provide two high data rate communication relays.

The TDRSS spacecraft will be deployed from the orbiter Challenger approximately 11 hours after launch. Transfer to geosynchronous orbit will be provided by the solid propellant inertial upper stage (IUS). Separation from the upper stage occurs approximately 17 hours after launch. Required earth pointing for TDRS commands and telemetry, plus thermal control maneuvers, will be done by the upper stage between first and second stage burns.

Deployment of the solar panels, C-band antenna and space ground link antenna occur prior to TDRS separation from the upper stage. The single access parabolic antennas deploy after separation and subsequent to acquisition of the sun and earth by spacecraft sensors utilized for attitude control. Attitude and velocity adjustments place the TDRS into its final geostationary position. The TDRS is three-axis stabilized with the body fixed antennas pointing constantly at the earth while the solar arrays track the sun.

The ground station network now in operation by NASA is able to provide communications support for only a small fraction (typically 15 percent) of the orbital period. The TDRSS network, when established, should provide coverage for almost the entire orbital period of a user spacecraft.

The TDRSS does no processing of user traffic, in either direction. Thus, the TDRSS operates as a "bent-pipe" repeater; in other words, it relays signals and data between the user spacecraft and ground terminal.

A TDRSS ground terminal has been built at White Sands, N.M., which provides a location at a longitude with a clear line-of-sight to the TDR satellites and a place where rain conditions do not interfere with the availability of the K-band uplink and downlink channels.

Also located at White Sands is the NASA Ground Terminal (NGT), which provides the interface between the TDRSS and the other TDRSS network elements which have their primary tracking and communication facilities at Goddard Space Flight Center in Greenbelt, Md. Also located at Goddard are the Network Control Center (NCC), which provides system scheduling and is the focal point for NASA communications with the TDRSS and the other TDRSS network elements; the Operating Support Computing Facility (OSCF), which provides the network with orbital predictions and definitive orbit calculations for user spacecraft and the TDRSS; and the NASA Communications Network (NASCOM), which provides the common carrier interface at network locations and consists of domestic satellites and their interface through earth terminals at Goddard, White Sands, and the Johnson Space Center in Houston, Texas.

The Network Control Center at Goddard contains data processing equipment and software. Console operators monitor the data, schedule emergency interfaces, isolate faults in the system, account for the system, test the system, and simulate user spacecraft. The user services available from the TDRSS network are sent through the NASA Communications Network (NASCOM), a global system that provides long-line operational communications support to all NASA projects. It offers voice, data, and teletype links with the TDRSS network, the Ground Spaceflight Tracking and Data Network (GSTDN) and the user spacecraft control centers. NASCOM's circuits are provided and operated by commercial carriers under contract to NASCOM, which sends the TDRSS user data to the Operations Support Computer Facility (OSCF) and to the Sensor Data Processing Facility (SDPF), also at Goddard. The Sensor Data Processing Facility receives the telemetry and image data directly from the users through TDRSS or a ground station via the NASCOM or from magnetic tapes recorded and mailed from a ground station. At the Sensor Data Processing Facility the data are processed and distributed, including editing, time tagging, decommutating, formatting, and applying ancillary data. In addition, selected data are monitored for fault isolation.

All of the telemetry data are routed directly to a user's Payload Operations Control Center (POCC). Each payload center is tailored to a specific space mission, providing support to one spacecraft or to a series of spacecraft in a project. Scientists, engineering and other technical experts in the center process experiment status, command and telemetry; handle attitude data for proper orientation of cameras and measuring instruments in the payload; control the payload operations and instrument sensors; and plan and analyze the mission.

The Payload Operations Control Center interfaces directly with the scientific investigators to plan payload experiment operations and to determine support requirements.

Thus, a coordinated ground effort exists between the TDRSS network's NASA Ground Terminal, Network Control Center, the NASA Communications Network, and each Payload Operations Control Center to unite users with their spacecraft for command, telemetry, and data.

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TDRS-1 DEPLOYMENT TIMELINE

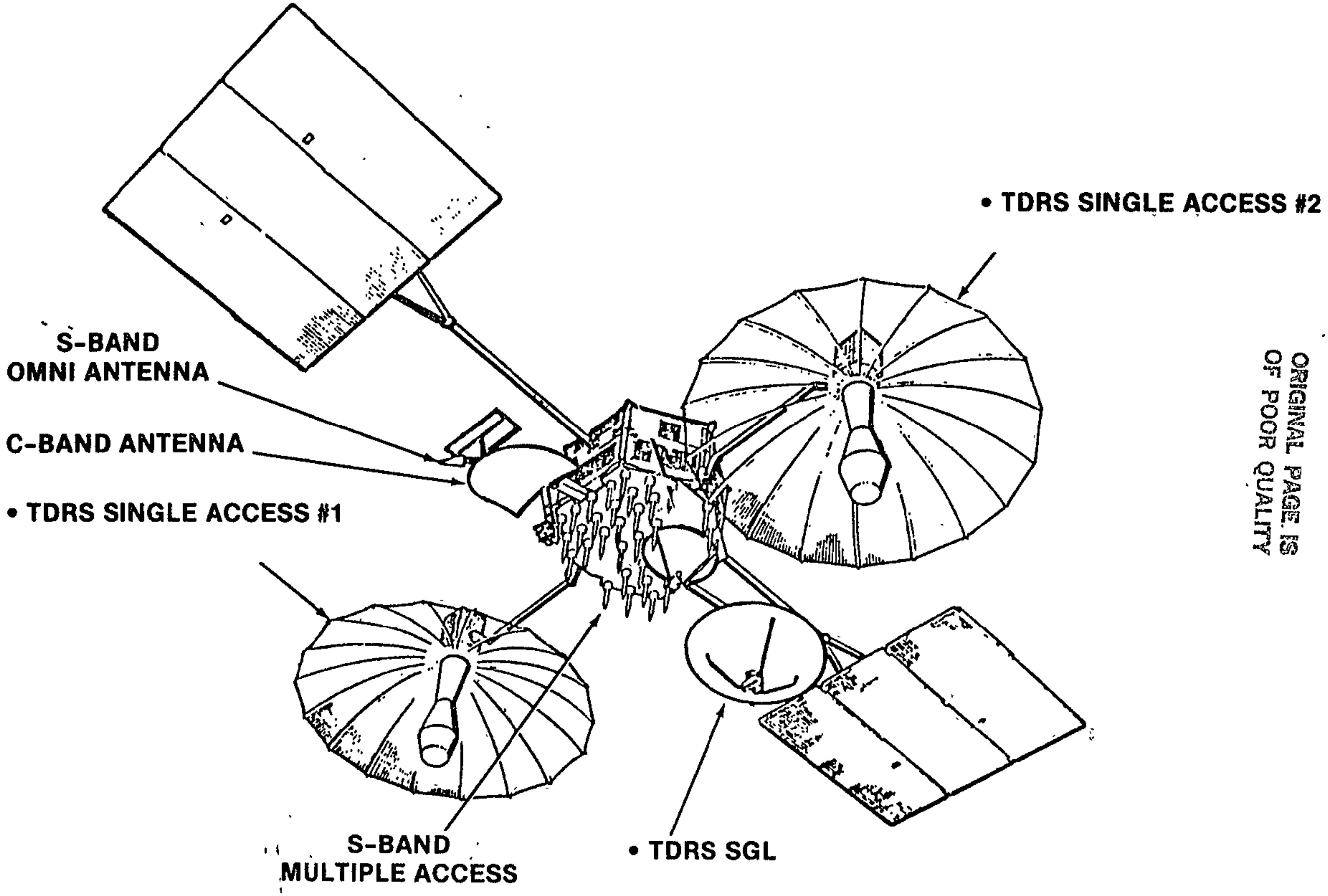
Nominal MET* (Mission Elapsed Time)	**Event**
01:45:00	Payload bay doors open.
08:25:00	TDRS tilt table elevated to 29 degrees.
09:16:00	Final TDRS pre-deployment radio frequency check.
09:21:00	Final "go/no go" to crew for deployment.
09:38:00	IUS switched to internal power.
09:48:00	TDRS tilt table elevated to 59 degrees.
10:01:22	IUS/TDRS deployed from payload bay. (Orbit #8, 153 nm altitude.)
10:19:00	Orbiter performs OMS separation maneuver.
10:56:00	IUS first stage ignited for 2-minute, 31-second burn injecting TDRS into transfer orbit. (Range about 32 miles from orbiter.) Transfer orbit phase (5 hours, 18 minutes), with IUS in thermal control mode. Five TDRS omnidirectional antenna "dipout" tests performed over tracking stations, two of which will involve the relay of commands from White Sands Ground Terminal.
16:14:00	IUS first stage jettisoned.
16:16:00	IUS second stage ignited for 1-minute, 43-second burn, placing TDRS into geosynchronous orbit at 56 degrees west longitude.
16:33:00	Deployment of solar panels begins.
16:37:00	Space/ground link antenna deployed.
16:45:00	C-band antenna deployed.
16:51:00	Solar panels in operating configuration.
16:55:00	IUS separation from TDRS.
17:08:00	Single access antenna (Ku- and S-band) deployment begins.
19:35:00	Single access antennas fully deployed.
21:47:00	TDRS in operating configuration.

Other Deployment Opportunities

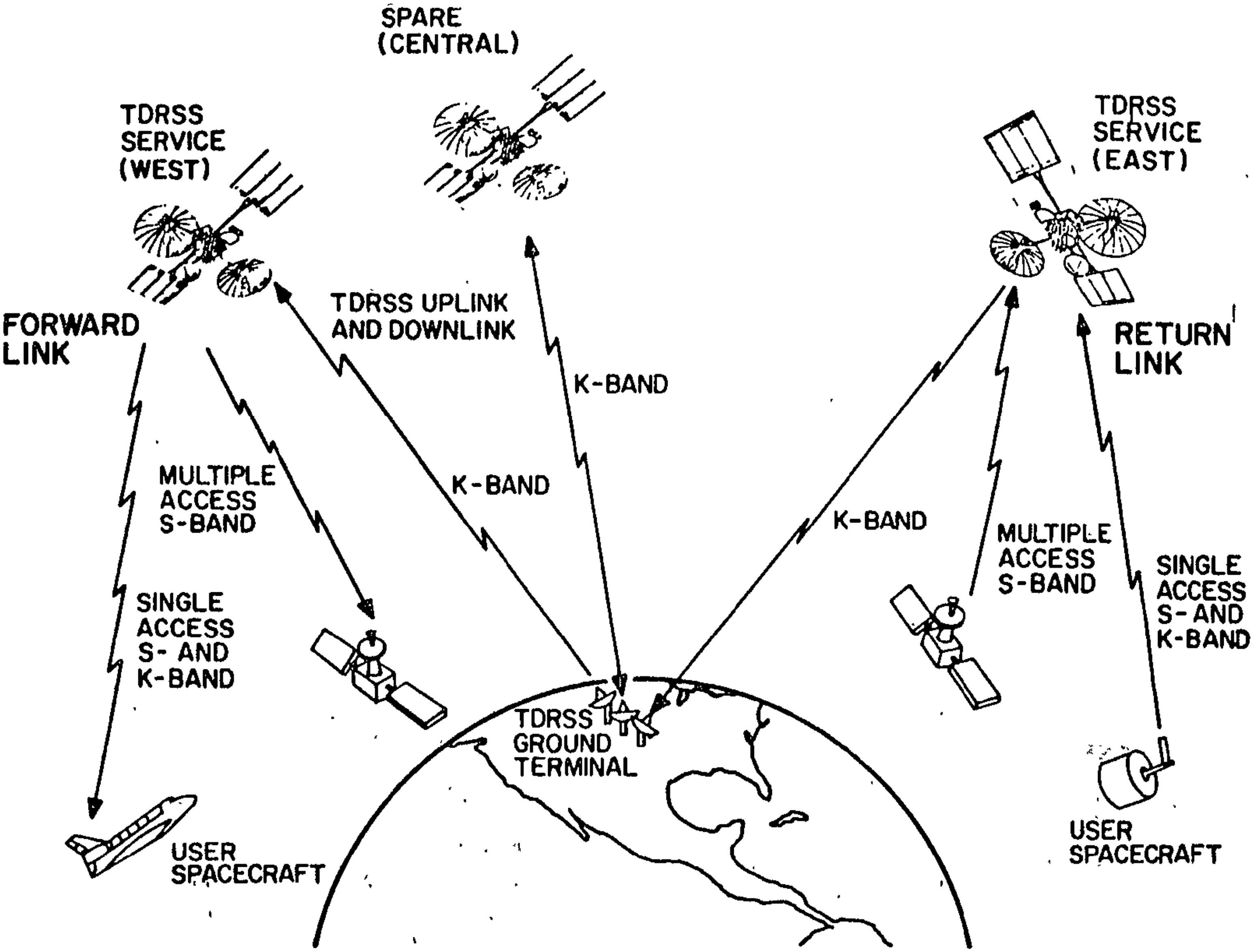
11:27:00	Orbit #9
13:00:00	Orbit #10
24:05:00	Orbit #18

*Minor changes may occur in this schedule.

SPACECRAFT CONFIGURATION



TDRSS CONCEPT



The TDR satellites are the largest privately owned telecommunications spacecraft ever built, each weighing about 2,268 kg (5,000 lb.). Each satellite spans more than 17.4 m (57 ft.) measuring across the solar panels. The single-access antennas, fabricated of woven molybdenum mesh and plated with 14K gold, each measure 4.9 m (16 ft.) in diameter, and when deployed, span more than 12.8 m (42 ft.) from tip to tip.

The TDR satellites are composed of three distinct modules: an equipment model, a communications payload module, and an antenna module. The modular structure reduces the cost of individual design and construction efforts that, in turn, lowers the cost of each satellite.

The equipment module housing the subsystems that operate the satellite and the communications service is located in the lower hexagon of the spacecraft. The attitude control subsystem stabilizes the satellite so that the antennas have the proper orientation toward the earth and the solar panels toward the sun. The electrical power subsystem consists of two solar panels that provide a 10-year life span of approximately 1,700 watts power. The thermal control subsystem consists of surface coatings and controlled electric heaters.

The communications payload module is composed of the electronic equipment and associated antennas required for linking the user spacecraft with the ground terminal. The receivers and transmitters are mounted in compartments on the back of the single-access antennas to reduce complexity and possible circuit losses.

The antenna module is composed of four antennas. For single-access services, each TDR satellite has two dual-feed S-band/Ku-band deployable parabolic antennas. These antennas are 4.9 m (16 ft.) attached on two axes that can move horizontally or vertically to focus the beam on orbiting spacecraft below. Those antennas are used primarily to relay communications to and from user spacecraft. The high bit-rate service made possible by these antennas is available to users on a time-shared basis. Each antenna simultaneously supports two user spacecraft services (one at S-band and one at Ku-band). For multiple-access service, the multi-element S-band phased array of helical radiators is mounted on the satellite body. The multiple-access forward link (between TDRS and the user spacecraft) transmits command data to the user spacecraft. In the return link, the signal outputs from the array elements are sent separately to the White Sands Ground Terminal parallel processors.

A fourth antenna, a 2-m (6.5-ft.) parabolic reflector, provides the prime link for relaying transmissions to and from the ground terminal at Ku-band.

The satellites are the first designed to handle telecommunications services through three frequency bands: S, Ku, and C.

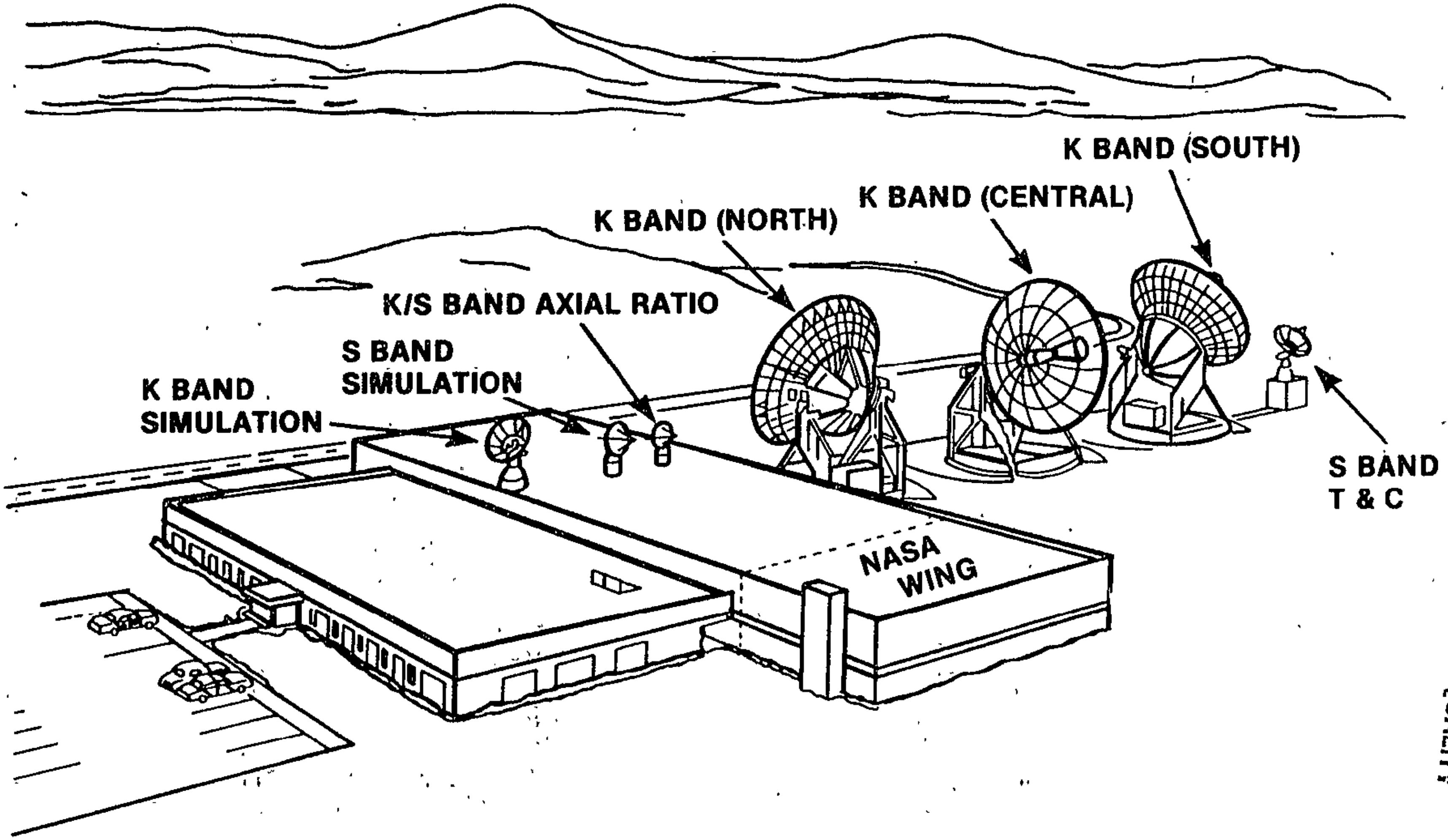
The TDRSS network will have all three satellites in geosynchronous orbit, over the equator. TDRS East will be located at 41 degrees west longitude over the Atlantic Ocean; TDRS West will be 171 degrees west longitude, about mid-Pacific Ocean. The position of the TDRS in-orbit spare tentatively has been assigned a location of 79 degrees west longitude, which is over the Pacific just off the coast of South America. The second TDRS satellite is scheduled for launch in June 1983, on STS-8, with TDRS-C scheduled for March 1984 on STS-12.

Under contract, NASA has leased the TDRSS from the Space Communications Co. (SPACECOM) of Gaithersburg, Md., the owner, operator and prime contractor for the system. SPACECOM was established as a wholly-owned subsidiary of the Western Union Corp. in 1976. In late 1979, Western Union reached an agreement with Fairchild Industries, Inc. and Continental Telephone Corp. for each to acquire a 25 percent interest in SPACECOM. The company is under contract to NASA to provide 10 years of continuous telecommunication services beginning in 1983. TRW Space and Technology Group in Redondo Beach, Calif., and the Harris Government Communications System Division in Melbourne, Fla., are the two prime subcontractors under SPACECOM for spacecraft and ground terminal equipment, respectively.

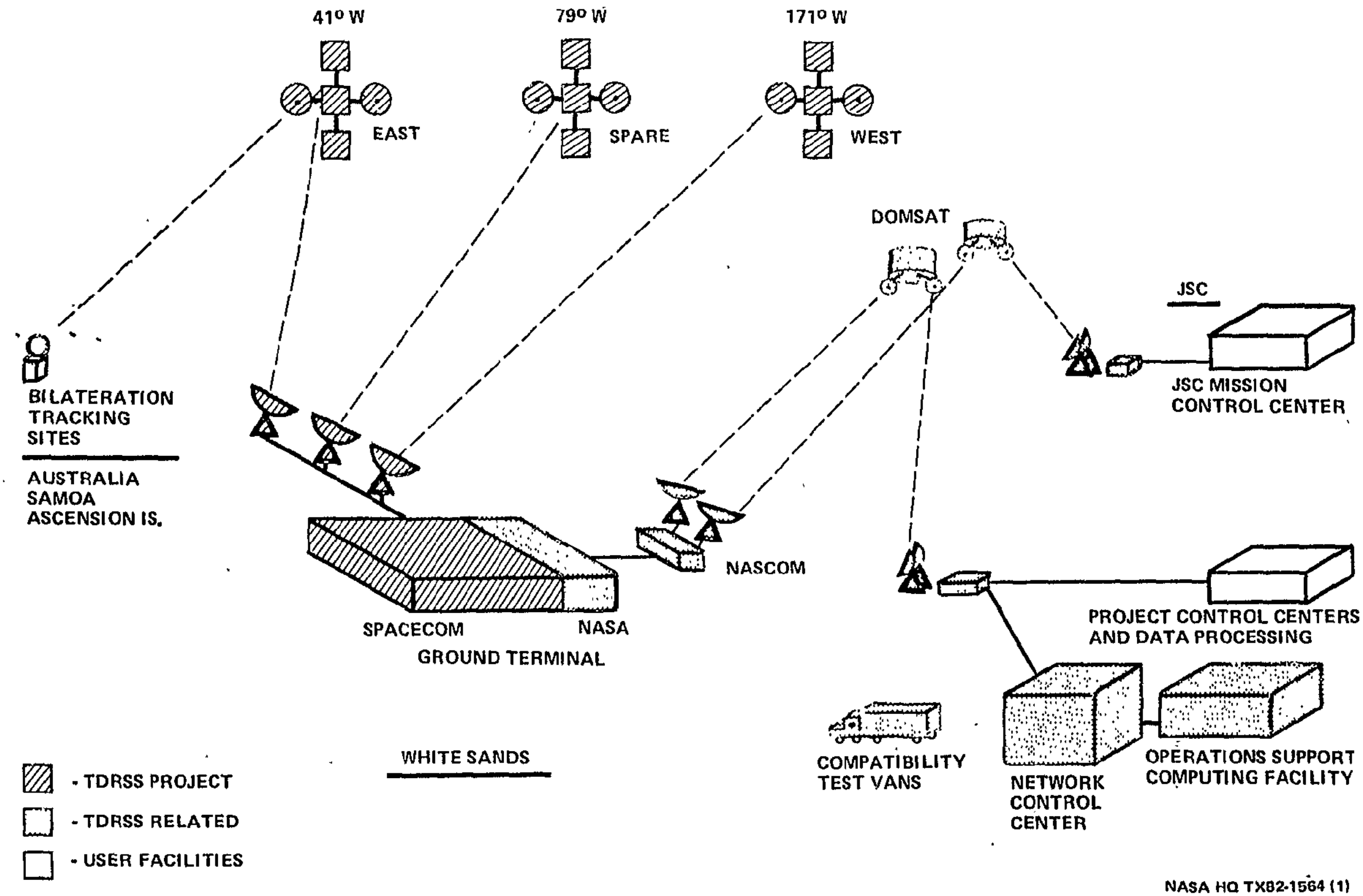
The satellite was rolled out at TRW's California plant on Nov. 4 and arrived at the Kennedy Space Center on Nov. 14.

The first scheduled user of the TDRSS network is the Landsat 4 earth resources satellite, which was launched from Vandenberg Air Force Base, Calif., last July 16. Landsat 4 is an experimental spacecraft with powerful remote-sensing capabilities from both a multispectral scanner and a thematic mapper. Other major users of the TDRSS include Spacelab and the Space Telescope. Other future users of the TDRSS network will include the Cosmic Background Explorer (COBE), which will explore the diffuse cosmic background radiation of the universe; Gamma Ray Observatory (GRO), which will make a high-sensitivity survey of the galactic plane to study galactic structure, gamma-ray emission and spatial variations; Earth Radiation Budget Experiment (ERBE), which will obtain an accurate measurement of the earth's monthly radiation budget for the upper atmosphere and for regional, zonal, and global spatial scales; and the Upper Atmosphere Research Satellite (UARS), which will study the chemistry and physical processes acting upon and within the stratosphere, mesospheres and the lower thermosphere.

WHITE SANDS GROUND TERMINAL



TDRSS SYSTEM ELEMENTS



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INERTIAL UPPER STAGE (IUS)

The Inertial Upper Stage (IUS) will be used to place NASA's Tracking and Data Relay Satellite (TDRS-A) into geosynchronous earth orbit.

The STS-6 crew will begin deployment activities approximately nine hours after Challenger reaches a low earth orbit of 283 km (153 nm, 176 st. mi.). Upper stage airborne support equipment, located in the orbiter payload bay, will be used to position the IUS/TDRS-A combined vehicle into the proper deployment attitude -- an angle of 59 degrees -- and "kick" it into low earth orbit. Deployment will be by a spring eject system..

Following deployment from Challenger's payload bay, the orbiter will move away from the IUS/TDRS-A to a safe distance. The first stage will fire about 55 minutes after deployment from the payload bay.

Following the aft (first) stage burn of two minutes 33 seconds, the solid fuel motor shuts down and the two stages separate. After coasting for several hours the forward (second) stage motor ignites at six hours 12 minutes after deployment for the final push to higher orbit. Following a 1-minute, 44-second burn, the forward stage will shut down as the IUS/TDRS-A reaches the predetermined geosynchronous orbit position.

Six hours 54 minutes after deployment from Challenger the forward stage will separate from the TDRS-A and perform an anticollision maneuver with its on board reaction control system.

After the IUS upper stage reaches a safe distance from the TDRS-1, the stage will relay performance data back to a NASA tracking station and then shut itself down seven hours five minutes after deployment from the payload bay.

A number of advanced features distinguish the IUS from other previous upper stages. It has the first completely redundant avionics system ever developed for an unmanned space vehicle. The system has the capability to correct in-flight features within milliseconds.

Other advanced features include a carbon composite nozzle throat that makes possible the high-temperature, long-duration firing of the IUS motors; and a redundant computer system in which the second computer is capable of taking over functions from the primary computer if necessary.

Physically, IUS is 5.18 m (17 ft.) long, 2.7 m (9 ft.) in diameter, and weighs more than 14,515 kg (32,000 lb.). The NASA version of the IUS contains 12,247 kg (27,000 lb.) of solid fuel propellant.

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The IUS-1 consists of an aft skirt; an aft (first) stage that contains 9,707 kg (21,400 lb.) of solid propellant fuel and generates 20,685 kg (45,600 lb.) of thrust; an interstage; a forward (second) stage that contains 2,720 kg (6,000 lb.) of propellant and generates 8,390 kg (18,500 lb.) of thrust; and an equipment support section. The equipment support section contains the avionics which provide guidance, navigation, telemetry, command and data management, reaction control and electrical power.

Solid propellant rocket motors were selected in the design of the IUS because of their compactness, simplicity, inherent safety, demonstrated reliability and lower cost.

An Air Force Inertial Upper Stage, similar to the NASA IUS-1, was launched in September 1982 aboard an Air Force Titan 34D expendable launch vehicle.

The IUS is built by the Boeing Aerospace Corp., of Seattle, Wash., under contract to the U.S. Air Force Systems Command. Marshall Space Flight Center, Huntsville, Ala., is NASA's lead center for IUS development and program management.

SPACEWALK INTO THE CARGO BAY

The extravehicular activity (EVA) planned for STS-6 is virtually a replay of that which had been planned for STS-5 and scrubbed because of equipment problems.

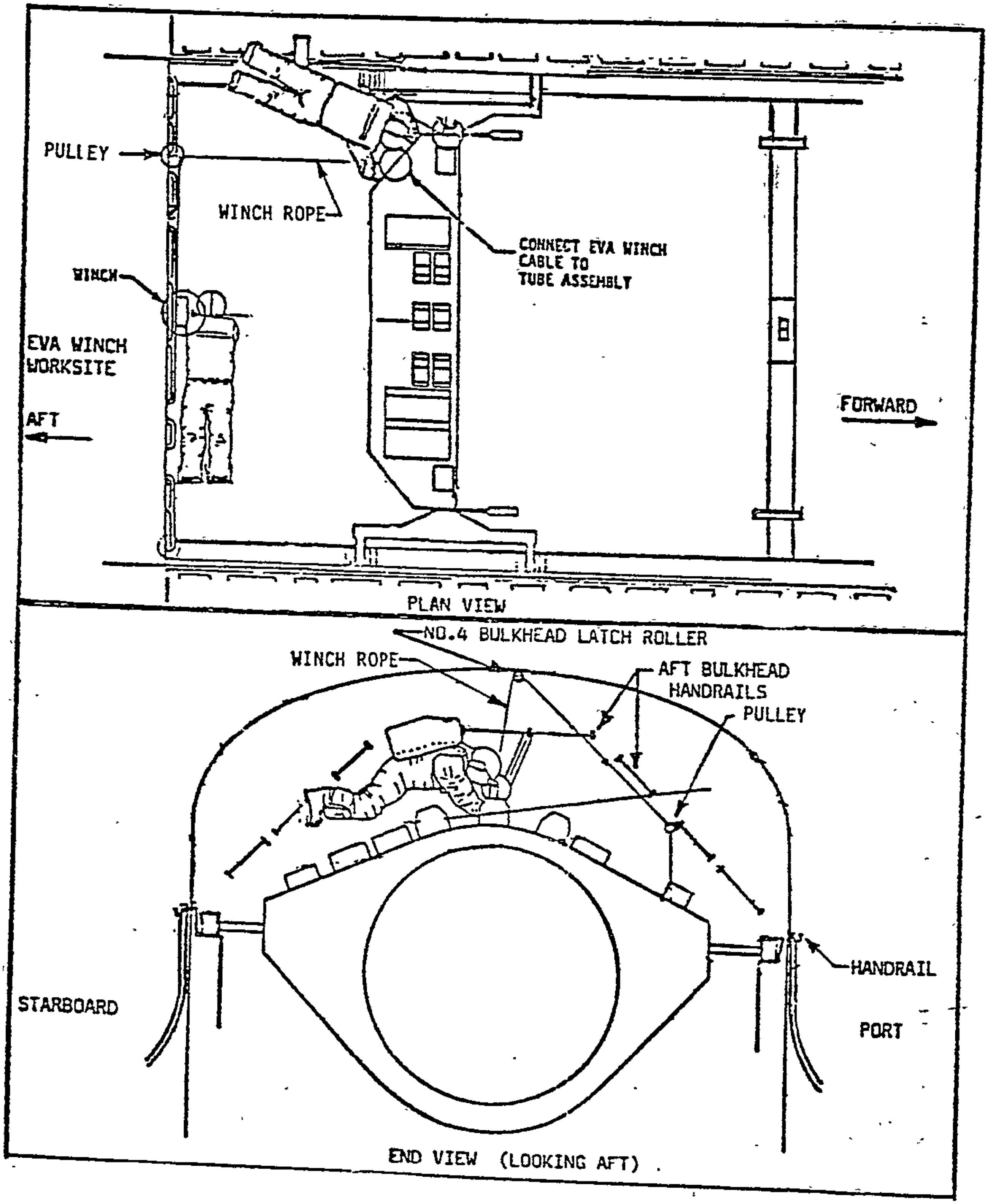
Mission specialists Donald Peterson and Dr. Story Musgrave will enter the airlock and don extravehicular mobility units (EMUs -- also known as spacesuits) before pre-breathing 100 percent oxygen for three hours. The orbiter cabin will remain pressurized at 14.7 psi during the extravehicular activity, planned for the fourth day of the flight.

After depressurizing the airlock to space vacuum, Peterson and Musgrave will attach safety tethers prior to moving aft along the hinge line slide wires to the aft bulkhead, one observing the other as each translates aft. Spacesuit status checks are scheduled throughout the extravehicular activity. Enroute to the aft bulkhead, both crewmen will inspect the now empty IUS cradle and evaluate payload bay lighting, suit radio communications and other aspects affecting future extravehicular activities.

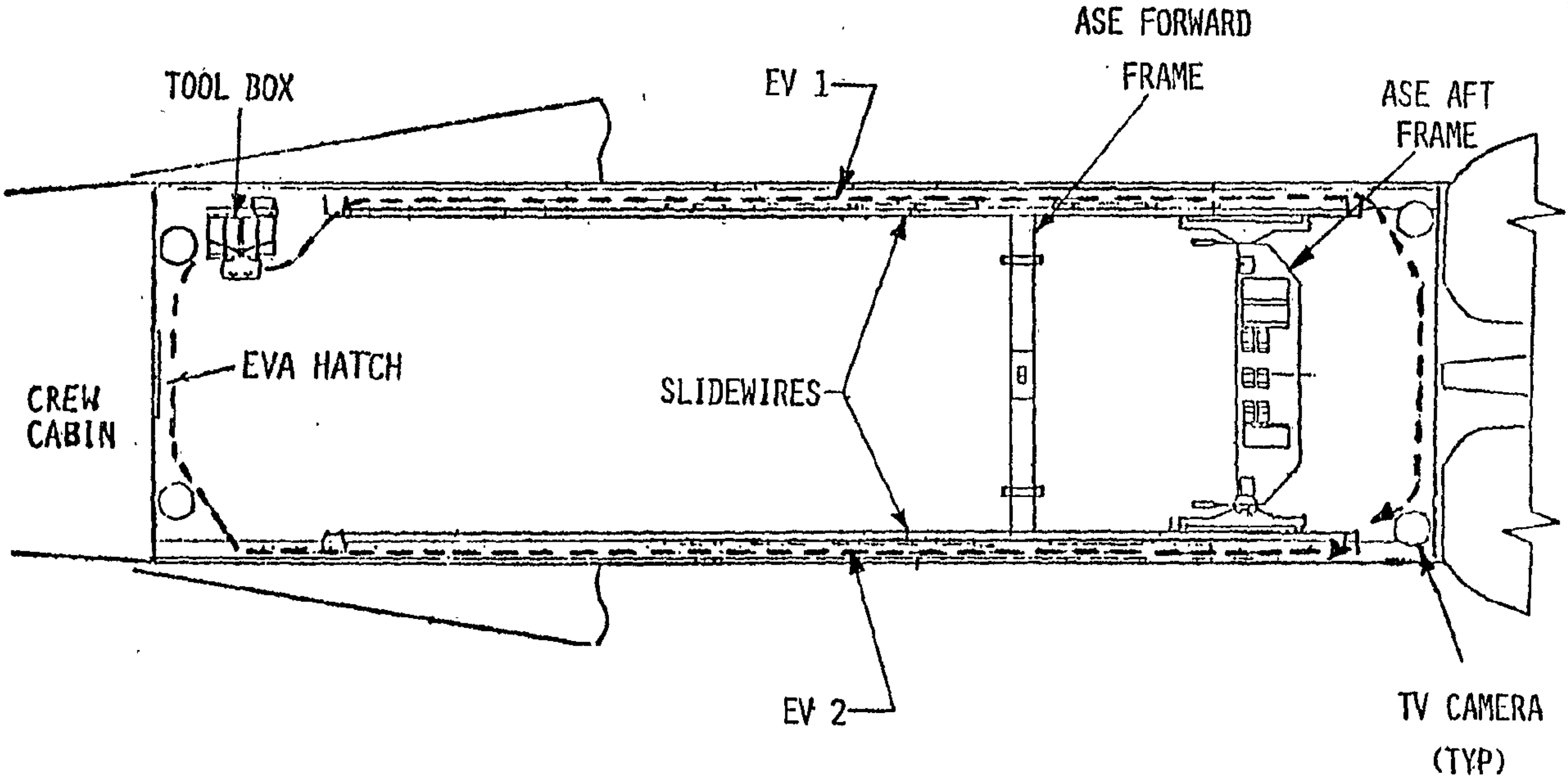
Translating forward to a work station and toolbox, both will next evaluate unstowage and handling of tools adapted or built for extravehicular activity use. While at the work station, spacesuit joint mobility and reach, and suit-to-body zero-g pressure points will be evaluated.

Both crewmen next move again to the aft bulkhead where they rig the aft winch cable through rollers and a snatch block to the IUS cradle to simulate contingency restowing of a stuck IUS cradle.

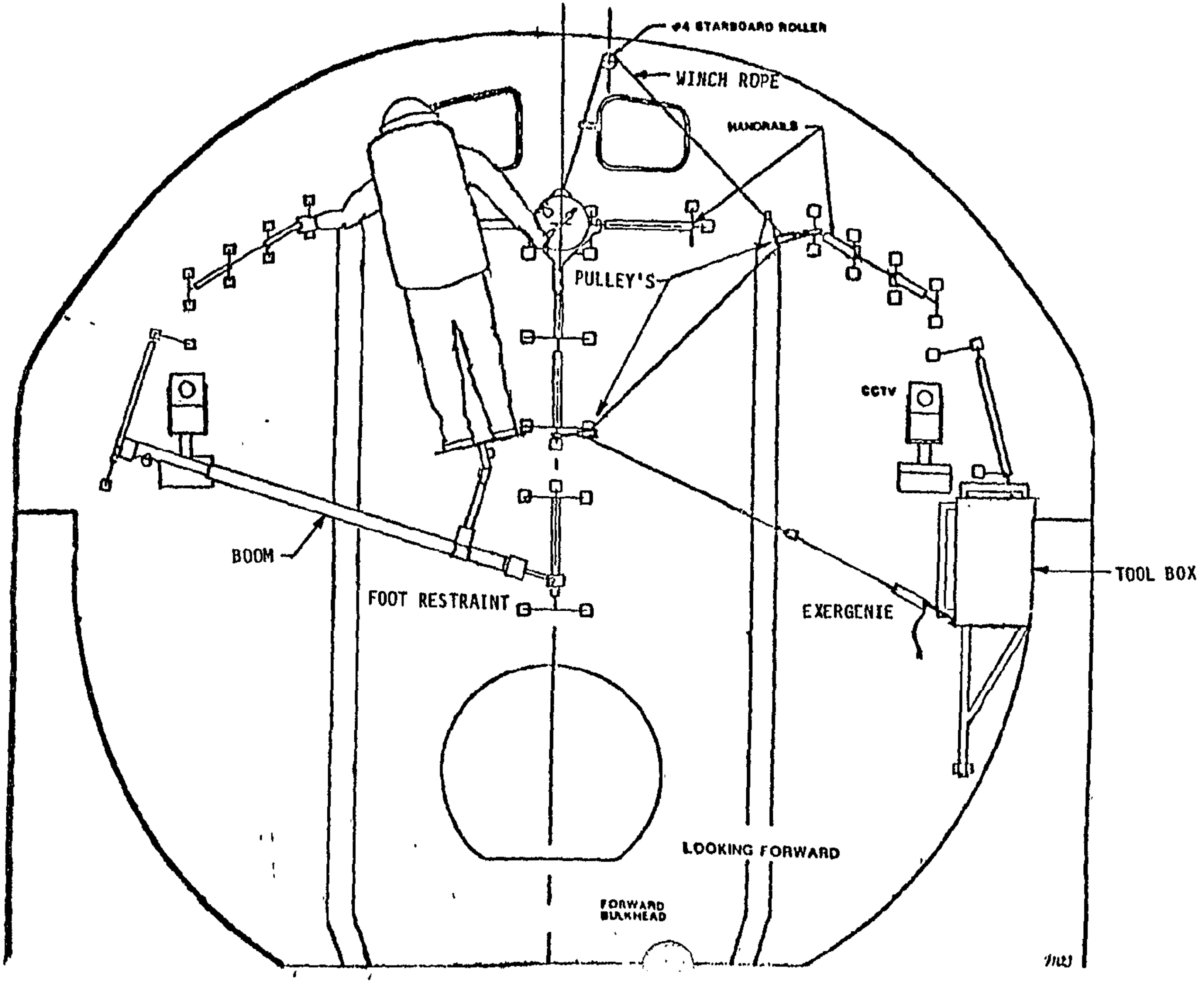
IUS CONTINGENCY EVA OPERATIONS



EVA TRANSLATION PATHS



FORWARD BULKHEAD WINCH OPERATIONS



Against the forward bulkhead, the crewmen operate the forward winch against an "Exergenie" acting as a dummy load on the winch line.

A bag of tools will be transformed into a sort of space barbell in an evaluation of moving an object of large mass as one crewman tows the tool bag to the aft bulkhead and back again.

Tools and equipment restowed, both men enter the airlock, close the hatch and repressurize to cabin pressure, ending the extravehicular activity at three and a half to four hours.

STS-6 EXPERIMENTS

ELECTROPHORESIS EXPERIMENT

The Continuous Flow Electrophoresis System, the first commercial experiment flown aboard the Space Shuttle, makes a return visit to space on STS-6. In addition to experimentation by the company, this flight marks the first use of the device by NASA scientists to expand the knowledge base of electrophoretic separation processes and further characterize the effects of gravity on continuous flow electrophoresis.

NASA's use of the system for its own research is part of the consideration provided to the space agency under the terms of the NASA/McDonnell Douglas Joint Endeavor Agreement. This agreement provides a vehicle for private enterprise and NASA to work together to promote the utilization of space where a technological advancement is needed and there is a potential commercial application.

During this flight McDonnell Douglas will seek to verify that the device separates materials to purity levels four times higher than those possible on earth. McDonnell Douglas separated samples of rat and egg albumin and cell culture fluid in the device during the STS-4 flight. Similar model protein samples will be separated on this flight.

NASA's first sample, which will be the initial sample to be run in the device during the mission, is a high concentration of hemoglobin and will be used to evaluate the flow profile during the continuous flow electrophoresis unit operating in weightlessness. The second NASA sample, a mixture of hemoglobin and a polysaccharide, is intended to evaluate resolution of the separation and investigate separation of different molecular configurations.

The agreement provides that general equipment performance data and the results from NASA's experiments using the device will be made public.

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The electrophoresis system, developed by the McDonnell Douglas Astronautics Co., St. Louis, Mo., and initially carried into space on STS-4, has the potential for separating biological materials for both research and the production of pharmaceuticals. The device is designed to separate biological materials according to their surface electrical charge as they pass through an electric field. Unlike previous electrophoresis experiments conducted in space on the Apollo-Soyuz Test Project and on STS-2, this device processes large quantities of materials carried in a continuous stream.

During the next two years, McDonnell Douglas' 249-kg (550-lb.), 1.8-m (6-ft.) high device is scheduled to be flown four more times in the orbiter middeck to identify materials that might be candidates for commercial development. Provided these experimental operations prove successful, the next step would be for a 2,268-kg (5,000-lb.) prototype production unit to be carried in the cargo bay on future Shuttle flights. This fully automated system will have 24 separation chambers, compared with the one chamber in the present unit.

The NASA experiments are supervised by Dr. Robert Snyder, Chief, Separation Processes Branch, Marshall Space Flight Center.

MONODISPERSE LATEX REACTOR

The Monodisperse Latex Reactor (MLR), is a materials processing in space experiment carried and operated in the middeck area of the orbiter cabin. The purpose of this experiment is to study the kinetics involved with the production of uniformly sized (monodisperse) latex beads (tiny spheres) in a low-gravity environment where the effects of buoyancy and sedimentation are minimized.

The experiment consists of four, 3-m (1-ft.)-tall reactors, each containing a chemical latex-forming recipe, housed in a .6-m (2-ft.)-tall metal cylinder. The recipe consists of a suspension of very small latex beads in water plus other chemical ingredients which cause the beads to polymerize when the experiment is activated on orbit.

The reactor was carried into space on two previous Shuttle missions. The experiment worked on its maiden voyage in space on STS-3 and produced quantities of 5-micron latex particles. During the STS-4 flight, the chemical processing was not completed because of a hardware malfunction. Engineers have since identified the malfunction and have made necessary modifications. On STS-6, the experiment will study the effects of varying processing parameters to better understand limitations in producing uniformly larger diameter spheres on earth. Latex spheres up to 10 microns in diameter are expected to be obtained.

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Monodispersed particles may have medical and industrial research applications. Some of the proposed applications of the latex beads include measuring the size of pores in the wall of the intestine in cancer research; measuring the size of pores in the human eye in glaucoma reasearch; and as a carrier of drugs and radioactive isotopes for treatment of cancerous tumors. The National Bureau of Standards has also indicated its interest in routine use of the beads as calibration standards in medical and scientific equipment.

Prior to launch, each of the reactors is loaded with 100 cubic centimeters of the chemical latex forming recipe. A small onboard computer will control the experiment after the Shuttle crew turns it on. In orbit, the latex mixture is heated to a constant 70-degree centigrade which initiates a chemical reaction to form the larger plastic beads. A recorder will store all data produced during operation of the experiment. The experiment requires about 20 hours of processing time. The reactor will be removed from the Challenger at the landing site and returned to the experimenters for sample and data analysis.

The principal investigator on the experiment is Dr. John W. Vanderhoff of Lehigh University, Bethlehem, Pa. The three co-investigators are Drs. Fortunato J. Micale and Mohamed S. El-Aasser, also of Lehigh, and Dale M. Kornfeld of the Marshall Space Flight Center.

NIGHTTIME/DAYLIGHT OPTICAL SURVEY OF THUNDERSTORM LIGHTNING

An experiment which studies lightning and thunderstorms from orbit is being flown again on STS-6. The experiment, entitled the Nighttime/Daylight Optical Survey of Thunderstorm Lightning, has been conducted on two previous Shuttle flights, STS-2 and STS-4. The techniques developed to identify lightning discharges in this experiment help in the development of sensors to identify severe weather situations from future meteorological satellites.

The lightning survey will be conducted by the Shuttle astronauts from the orbiter crew compartment using a motion picture camera to study lightning flashes visible above thunderstorms. When a target is in view, a crew member will use the camera to photograph through the windows of the crew cabin and will narrate his observations onto one channel of a tape recorder.

The experiment hardware consists of a 16-mm data acquisition camera, a two-channel cassette tape recorder, and a photo-optical detector mounted on the camera.

Lightning discharges are detected by the photo-optical system (photocell), which creates an electronic pulse in response to the detection of a lightning flash. These pulses will be recorded on the other recorder channel. A lightning event, which is visible as only one flash, is usually composed of many separate discharges, or strokes,,which are distinguished by the photocell.

Thus, the photocell will also be used to study individual lightning strokes. In order to synchronize the photo-optical system pulses with the film in the camera, signals corresponding to camera shutter pulses will be recorded on the same track of the tape recorder as the astronaut narration.

The motion picture camera also will be used during the day to film cloud structure and the convective circulations of storms.

Candidate storms for this experiment will be targeted for the astronauts by a team of scientists at Marshall's Space Science Laboratory using a sophisticated developmental weather system called the Man-Computer Interactive Data Access System (McIDAS). When a potential storm is identified along the projected track path of the orbiter, the coordinates are given to Mission Control at the Johnson Space Center so that the astronauts will be alerted. The data access system is a NASA and National Oceanic and Atmospheric Administration (NOAA) sponsored system based at the University of Wisconsin.

According to scientists who are analyzing the experiment results to date, the most impressive data gathered during the fourth Shuttle flight last June shows lightning bolts which formed a huge "Y" shape illuminating an area as large as 400 square kilometers. The photographs of the thunderstorms from orbit, taken over South America during a night pass, revealed lightning bolts as long as 40 km (25 mi.), and simultaneous occurrences of lightning 100 km (62 mi.) away.

Principal investigator is Dr. Bernard Vonnegut, of the State University of New York, Albany; co-investigators are Otha Vaughan Jr., of Marshall's Space Sciences Laboratory and Dr. Marx Brook, of the New Mexico Institute of Mining and Technology, Socorro.

GETAWAY SPECIAL

Officially titled Small Self-Contained Payloads, the Getaway Special program is offered by NASA to provide anyone who wishes the opportunity to fly a small experiment aboard the Space Shuttle. The experiment must be of a scientific research and development nature.

The Getaway Specials, which are flown on Shuttle missions on a space-available basis, are available to industry, educational organizations, and domestic and foreign governments, as well as individual citizens for legitimate scientific purposes.

Three Getaway Special payloads will fly on STS-6. They are:

* **Artificial Snow Crystal Experiment** - a $10,000, 5 cubic-foot experiment, sponsored by the Asahi Shimbun newspaper in Tokyo.

- **Seed Experiment** - a $3,000, 2 1/2 cubic-foot experiment by the George W. Park Seed Co. of Greenwood, S.C.
- **SCENIC FAST** - (FAST meaning FAlcon Shuttle Test) a $10,000, 5 cubic-foot experiment designed by U.S. Air Force Academy cadets at Colorado Springs. The payload contains six separate experiments.

The Asahi Shimbun, one of the largest newspapers in Japan with circulation of eight million, selected the snow crystal experiment from 17,000 ideas solicited from its readers. The idea to make artificial snowflakes in the weightlessness of space was proposed by two Japanese high school students, Haruhiko Oda and Toshio Ogaway (both boys).

The reason the Asahi Shimbun chose the snow experiment stems from the fact that the first artificial snow crystal in the world was made and investigated by a Japanese physicist, the late Ikichiro Nakaya, in 1936.

The payload was designed and manufactured by Nippon Electric Co. (NEC), the leading satellite maker in Japan. NEC has made 15 of 23 Japanese satellites.

The heart of the payload is two identical small copper boxes 4 cm x 4 cm x 10 cm (1.5 in. x 1.5 in. x 3.9 in.). Two semiconductor cooling modules are attached to each box to cool down the inside of the boxes to 15 Centigrade (59 Fahrenheit). On the end of the box, there is a small water container made of porous sintered metal in which 20 grams (.7 of an ounce) of water is stored.

In the near zero weightlessness of orbit, the water in the container will be heated by a simple electrical heater up to 20-30 C (68-86 F) to generate water vapor which will be supplied continuously into the cooled box. Then, a very small platinum heater on which a few milligrams of silver iodine is attached will be heated up. The silver iodine will sublimate and small particles of the silver iodine will serve as seeds of nuclei for artifical snow crystals.

Scientists have speculated that there will be very symmetrical snow crystals in weightlessness or that some spherical crystals may be formed in space, but no one knows the correct answer.

The snow crystals formed in space will be recorded on videotape with four TV cameras and four video tape recorders (VTRs). The lenses of the TV camera will magnify the images of the crystals.

The experiment is expected to contribute to crystallography, especially the crystal growth of semi-conductors or other materials from a vapor source.

The Park Seed Co. will send 11.3 kg (25 lb.) of common fruit and vegetable seeds into orbit. The 40 varieties -- from potatoes to sweet corn -- will be aboard the Shuttle, according to George Park, Jr., assistant vice president.

Park explained that 21st Century space stations and lunar bases will have to grow their own food from seeds in special, enclosed environments because food itself is too bulky to carry into space.

As a result, the Park Co. believes there's a market in the future.

The firm's primary objective is to determine how seeds must be packaged to withstand space flight.

While nothing will be grown in the seed experiment, seeds will be germinated once they are returned to earth. Two other identical groups of seeds left on the ground also will be studied for comparison.

Some of the seeds are packaged in simple Dacron bags, and others are sealed airtight in plastic pouches. One seed batch will be packed along the perimeter of the metal Getaway Special canister that houses the experiment, leaving it exposed to severe temperatures and cosmic radiation. Another batch of seeds will be sealed in the center of the canister where there is greater shielding from the space environment.

Researchers with the seed company plan to study the effects of the extreme temperature changes and radiation on the seeds. In some instances, extra doses of radiation may be beneficial to farmers, Park explained, who welcome a greater probability of seed mutations. With mutations come a genetic diversity that might mean hardier breeds of plants, he said.

Extreme fluctuations in temperatures, on the other hand, he explained, might take their toll. Park believes this experiment will provide some ground rules for the future transport of food in space.

The six experiments being conducted by the U.S. Air Force Academy cadets were developed in an engineering design course during the past five years. Four of the experiments are controlled by an internal sequencer, while the other two will be turned on separately. The two have independent battery power.

The responsibility of integrating all of the experiments and preparing them for spaceflight is in the hands of Maj. John E. Hatelid, an Assistant Professor of Astronautics and six First Class (Senior) cadets.

The experiments, in sequence, and their project cadets are:

- **Metal Beam Joiner** - to demonstrate that soldering of beams can be accomplished in space. Cadet First Class Harry N. Gross, 21, Harrisburg, Pa.
- **Metal Alloy** - to determine if tin and lead will combine more uniformly in a zero-gravity environment. Cadet First Class Mark Amidon, 21, Coraopolis, Ohio.
- **Foam Metal** - to foam metal in zero-gravity forming a metallic sponge. Cadet First Class Richard R. Neel II, 21, Dillonville, Ohio.
- **Metal Purification** - to test the effectiveness of the zone-refining methods of purification in a zero-gravity environment. Cadet First Class Joseph M. Streb, 22, Marriottsville, Md.
- **Electroplating** - to determine how evenly a copper rod can be plated in a zero-gravity environment. Cadet First Class Lawrence J. Peter, 21, Cincinnati, Ohio.
- **Microbiology** - to test the effects of weightlessness and space radiation on micro-organism development. Cadet First Class Kenneth R. Shriner, 21, Livonia, Mich.

At a designated time in the flight, an astronaut will turn on two switches to start the electronically-sequenced experiments. Upon return from orbit, the experiment samples will be compared to base-line samples produced on earth.

The Getaway Special Program is managed by the Goddard Space Flight Center. Project Manager is James S. Barrowman. Clarke Prouty, also of Goddard, is technical liaison officer. Program Manager at NASA Headquarters, Washington, D.C., is Donna S. Miller.

HUNTSVILLE SUPPORT CENTER

The Huntsville Operations Support Center is a facility at the Marshall Space Flight Center which supports launch activities at the Kennedy Space Center. The operations center also supports powered flight and payload operations at the Johnson Space Center.

During pre-mission testing, countdown, launch, and powered flight toward orbit, Marshall and contractor engineers man consoles in the support center to monitor real-time data being transmitted from the Shuttle. Their purpose is to evaluate and help solve problems that might occur with Marshall-developed Space Shuttle propulsion system elements, including the Space Shuttle main engines, external tank, and solid rocket boosters.

They will also work problems with the overall main propulsion system and the range safety system.

The data providing information on the health of these systems are gathered by sensors aboard the Shuttle and are instantaneously transmitted from the launch site to the two-story Huntsville Operations Support Center. There the information is processed by computers and displayed on screens and other instruments at 12 stations in the Engineering Console Room. More than 3,000 temperature, pressure, electrical voltage and other measurements are made every second. During the 10 hours of peak activity before and during launch, more than 11 million measurements are assessed by teams of experts in the support center.

Support center personnel view the Shuttle via two closed circuit television lines. They also have access to more than 25 direct communications lines that link them with the launch site at Kennedy, Mission Control at Johnson, and with Shuttle propulsion system contractor plants.

If a problem is detected at one of the stations in the support center console room, engineers on the consoles immediately alert appropriate individuals at the Kennedy and Johnson Centers, and operations center managers in the Shuttle action center, a conference room adjacent to the console room. They also pass the information to the appropriate teams of specialists in the operations center working area nearby. There are separate teams to work Space Shuttle Main Engine, external tank, solid rocket booster, main propulsion system, and range safety system difficulties.

In addition to launch support, payload services are provided by teams of scientists operating out of specially equipped payload support rooms.

SPACEFLIGHT TRACKING AND DATA NETWORK

One of the key elements in the Shuttle mission is the capability to track the spacecraft, comunicate with the astronauts and obtain the telemetry data that informs ground controllers of the condition of the spacecraft and the crew.

The hub of this network is NASA's Goddard Space Flight Center in Greenbelt, Md., where the Spaceflight Tracking and Data Network (STDN) and the NASA Communications Network (NASCOM) is located.

STDN is a complex NASA worldwide system that provides realtime communications with the Space Shuttle orbiter and crew. The network is operated by Goddard. Approximately 2,500 personnel are required to operate the system.

The network consists of 15 ground stations equipped with 4.3-, 9-, 12- and 26-m (14-, 30-, 40- and 85-ft.) S-band antenna systems and C-band radar systems, augmented by 15 DOD geographical locations providing C-band support and one DOD 18.3-m (60-ft.) S-band antenna system.

In addition, there are six major computing interfaces located at the Network Operations Control Center and at the Operations Support Computing Facility, both at Goddard; Western Space and Missile Center, Calif.; Air Force Satellite Control Facility, Colo.; White Sands Missile Range, N.M.; and Eastern Space and Missile Center, Fla., providing realtime network computational support.

The network has agreements with the governments of Australia, Spain, Senegal, Botswana, Chile, United Kingdom and Bermuda to provide NASA tracking station support to the Space Transportation System program.

Should the Johnson Mission Control Center be seriously impaired for an extended period of time, the Goddard Network Operations Control Center becomes an emergency mission center manned by Johnson personnel, with the responsibility of safely returning the orbiter to a landing site.

The Merritt Island, Fla., S-band station provides the appropriate data to the Launch Control Center at Kennedy and the Johnson Mission Control Center during prelaunch testing and the terminal countdown. During the first minutes of launch and during the ascent phase the Merritt Island and Ponce de Leon, Fla., S-band and Bermuda S-band stations, as well as the C-band stations located at Bermuda; Wallops Island, Va.; Grand Bahama; Grand Turk; Antigua; Cape Canaveral and Patrick Air Force Base, Fla., provide appropriate tracking data, both high speed and low speed, to the Kennedy and Johnson control centers.

During the orbital phase, all the S-band and some of the C-band stations that see the Space Shuttle at 3 degrees above the horizon support and provide appropriate tracking, telemetry, air-ground and command support to the Mission Control Center at Johnson through Goddard.

During the nominal entry and landing phase planned for Edwards Air Force Base, Calif., the Goldstone and Buckhorn, Calif., S-band and C-band stations at the Pacific Missile Test Center, Vandenberg Air Force Base, Edwards Air Force Base and Dryden Flight Research Facility, Calif., will provide highly critical tracking, telemetry, command and air-ground support to the orbiter and send appropriate data to the Johnson and Kennedy control centers.

NASA TRACKING STATIONS

LOCATION	EQUIPMENT
Ascension Island (ACN)	S-band, UHF A/G
Bermuda (BDA)	S-band, C-band, UHF A/G
Buckhorn (BUC)	S-band, C-band
Goldstone (GDS)	S-band, UHF A/G
Guam (GWM)	S-band, UHF A/G
Hawaii (HAW)	S-band, UHF A/G
Merritt Island (MIL)	S-band, UHF A/G
Santiago (AGO)	S-band
Ponce de Leon (PDL)	S-band
Madrid (MAD)	S-band, UHF A/G
Orroral (ORR)	S-band
Botswana (BOT)	UHF A/G
Dakar (DKR)	UHF A/G
Wallops (WFF)	C-band
Yarragadee (YAR)	UHF A/G

Personnel:

Tracking Stations; 1,110*

Goddard Space Flight Center; 1,400

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* More than 500 of whom are local residents

CREW BIOGRAPHIES

NAME: Paul J. Weitz (pronounced WHITES) (Captain, USN, Retired) NASA Astronaut, STS-6 Commander

BIRTHPLACE AND DATE: Born in Erie, Pa., on July 25, 1932. His mother, Mrs. Violet Futrell, now resides in Norfolk, Va.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 ft., 10 in.; weight: 180 lb.

EDUCATION: Attended McKinley Elementary School in Erie, Pa., and Harborcreek High School in Harborcreek, Pa.; received a bachelor of science degree in aeronautical engineering from Pennsylvania State University in 1954 and a master's degree in aeronautical engineering from the U.S. Naval Postgraduate School in Monterey, Calif., in 1964.

MARITAL STATUS: Married to the former Suzanne M. Berry of Harborcreek, Pa.; her father is John H. Berry.

CHILDREN: Matthew J., Sept. 23, 1958; Cynthia A., Sept. 25, 1961.

NASA EXPERIENCE: Weitz is one of the 19 astronauts selected by NASA in April 1966.

Weitz served as pilot on Skylab 2 (SL-2), the first manned Skylab mission, which launched on May 25 and ended on June 22, 1973. With him for the initial activation and 28-day flight qualification operations of the Skylab orbital workshop were Charles Conrad, Jr., (spacecraft commander) and Joseph P. Kerwin (science-pilot).

In logging 672 hours and 49 minutes aboard the workshop, the crew established a new world record for a single mission. Weitz also logged 2 hours and 11 minutes in extravehicular activities.

Weitz retired from the United States Navy on June 1, 1976, with 22 years of service, but remains with NASA as a civilian astronaut.

NAME: Karol J. Bobko (Colonel, USAF)
NASA Astronaut, STS-6 Pilot

BIRTHPLACE AND DATE: Born in New York City, on Dec. 23, 1937. His parents, Mr. and Mrs. Charles P. Bobko, reside in Gulf Harbors, Fla.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 ft., 11 in.; weight: 190 lb.

EDUCATION: Graduated from Brooklyn Technical High School, New York; received a bachelor of science degree from the Air Force Academy in 1959 and a master of science degree in aerospace engineering from the University of Southern California in 1970.

MARITAL STATUS: Married to the former F. Dianne Welsh of Denver, Colo. Her mother, Mrs. Ann Frances Welsh, resides in Denver.

CHILDREN: Michelle A., Feb. 8, 1963; Paul J., Dec. 1, 1965.

NASA EXPERIENCE: Bobko became a NASA astronaut in September 1969. He was a crew member on the highly successful Skylab Medical Experiments Altitude Test (SMEAT) -- a 56-day simulation of the Skylab mission, enabling crewmen to collect medical experiments baseline data and evaluate equipment, operations and procedures.

Bobko was a member of the astronaut support crew for the Apollo-Soyuz Test Project (ASTP). This historic first international manned space flight was completed in July 1975. Subsequently, he was a member of the support crew for the Space Shuttle approach and landing tests conducted at Edwards Air Force Base, Calif. He served alternately as capsule communicator and prime chase pilot during these approach and landing test (ALT) flights.

In preparation for the first flight of Columbia (STS-1), Bobko served as the lead astronaut in the test and checkout group at Kennedy Space Center.

NAME: Story Musgrave (M.D.)
NASA Astronaut, STS-6 Mission Specialist

BIRTHPLACE AND DATE: Born Aug. 19, 1935, in Boston, Mass., but considers Lexington, Ky., to be his hometown. His mother, Mrs. Marguerite Swann Musgrave, resides in Houston, Texas.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 ft., 10 in.; weight: 149 lb.

EDUCATION: Graduated from St. Mark's School, Southborough, Mass., in 1953; received a bachelor of science degree in mathematics and statistics from Syracuse University in 1958, a master of business administration degree in operations analysis and computer programming from the University of California at Los Angeles in 1959, a bachelor of arts degree in chemistry from Marietta College in 1960, a doctorate in medicine from Columbia University in 1964, and a master of science in physiology and biophysics from the University of Kentucky in 1966.

MARITAL STATUS: Single.

CHILDREN: Lorelei Lisa, March 27, 1961; Bradley Scott, July 3, 1962, Holly Kay, Dec. 13, 1963; Christopher Todd, May 12, 1965; and Jeffrey Paul, June 19, 1967.

NASA EXPERIENCE: Dr. Musgrave was selected as a scientist-astronaut by NASA in August 1967. He completed astronaut academic training and a year of military flight training. He worked on the design and development of the Skylab Program, was the backup science-pilot for the first Skylab mission, and was a capsule communicator for the second and third Skylab missions. He was the mission specialist on the first and second Spacelab Mission Simulations. Musgrave participated in the design and development of all Space Shuttle extravehicular activity equipment including spacesuits, life support systems, airlocks, and manned maneuvering units. From 1979 to 1982, he was assigned as a test and verification pilot in the Space Shuttle avionics integration laboratory at JSC. He has continued clinical and scientific training as a part-time surgeon at the Denver General Hospital and as a part-time professor of physiology and biophysics at the University of Kentucky Medical Center.

NAME: Donald H. Peterson (Colonel, USAF, Retired)
NASA Astronaut, STS-6 Mission Specialist

BIRTHPLACE AND DATE: Born in Winona, Miss., on Oct. 22, 1933. His parents, Mr. and Mrs. Henry W. Peterson, reside in Winona.

PHYSICAL DESCRIPTION: Blond hair; green eyes; height: 5 ft., 8 in.; weight: 147 lb.

EDUCATION: Graduated from Winona City High School, received a bachelor of science degree from the United States Military Academy at West Point, N.Y., in 1955, and a master's degree in nuclear engineering from the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, in 1962.

MARITAL STATUS: Married to the former Bonnie Love of Coffeeville, Miss. Her parents, Mr. and Mrs. Tom Love, reside in Coffeeville.

CHILDREN: Donald H. Jr., July 16, 1958; Jean M., Nov. 17, 1959; Shari L., Aug. 28, 1962.

NASA EXPERIENCE: Peterson became a NASA astronaut in September 1969. He served on the astronaut support crew for Apollo 16.

Peterson retired from the United States Air Force with the rank of colonel after having completed more than 24 years of active service, but continues his assignment as a NASA astronaut in a civilian capacity. His areas of responsibility have included engineering support, man/machine interface, and safety assessment.

SPACE SHUTTLE PROGRAM MANAGEMENT

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Lt. Gen. James A. Abrahamson	Associate Administrator for Space Flight
Jesse W. Moore	Deputy Associate Administrator for Space Flight
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Robert O. Aller	Director, Tracking and Data Relay Satellite System Division
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Eugene Ferrick	Chief, TDRSS Operations

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DRYDEN FLIGHT RESEARCH FACILITY

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